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Working Paper

MANPRINT ANALYSIS OF THE DIVAD SYSTEM:

VOLUME I. HUMAN FACTORS DATA FROM SGT YORK FOLLOW-ON EVALUATION I

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FOREWORD

This report is the first of two volumes presenting a MANPRINT analysis of the Division Air Defense (DIVAD) Gun System, also known as Sgt York. The first volume is a consolidation and analysis of the human factors data obtained from the Sgt York Follow-On Evaluation I tests. The second volume is a discussion of the lessons learned from that experience.

Even though MANPRINT requirements were not imposed on Sgt York during FOE I, the MANPRINT areas provided a comprehensive set of focal points in evaluating the outcome of FOE I in Volume I, MANPRRINT Analysis of the DIVAD System: I. Human Factors Data from Sgt York Follow-On Evaluation I; and Volume II, MANPRINT Analysis of the DIVAD System: II. Lessons Relearned. MANPRINT as an integrated approach to dealing with the human element in system design, development, and test is a comparatively new initiative. MANPRINT conveys a concern for Army "people problems" by focusing on six areas: (1) human factors engineering, (2) manpower, (3) personnel, (4) training, (5) system safety, and (6) health hazards. MANPRINT issues identified within the six categories are addressed in both volumes.

From 2 April 1985 to 15 June 1985, Follow-On Evaluation tests were conducted to support an assessment of the Division Air Defense (DIVAD) Gun System, the Sgt York. The Force-on-Force phase was conducted at the Combat Development Experimentation Center (CDEC) at Fort Hunter-Liggett, CA, and the Live Fire phase was conducted at White Sands Missile Range in New Mexico.

Essex Corporation was under contract (MDA903-85-C-0229) to the U.S. Army Research Institute for the Behavioral and Social Sciences to carry out human factors, training, and safety analyses of the Sgt York. Mr. George Gividen, Chief of the ARI Field Unit at Fort Hood and ARI coordinator for human factors on the Sgt York FOE I test, was the Contracting Office Technical Representative (COTR) for that contract. A seven-man Essex human factors team was on-site as the Force-on-Force and Live Fire phases of the Sgt York FOE I tests were conducted. A preliminary account of the human factors, safety, and training results of FOE I was supplied for incorporation in the Operational Test and Evaluation Agency (OTEA) report on FOE I. Those results also provided the foundation for this two-volume work. Actual report preparation was covered under Contract MDA903-83-C-0033 as one of the Task 3 Methodology studies. Dr. Charles O. Nystrom is the COTR on that contract.

A debt of gratitude is owed to the seven human factors specialists who conducted the human factors, safety, and training portion of the Sgt York FOE I tests. These individuals,

Mr. Richard H. Hiss, Mr. John R. Rice, Dr. Spencer C. Thomason, Mr. C. Henry DeBow, Mr. Charles R. Sawyer, Mr. Philip Durham, and Mr. John C. Cotton, designed the test plan for the Live Fire and Force-on-Force, collected, recorded, and analyzed data which was used as the foundation for this volume. These Essex employees represented the Army Research Institute for the Behavioral and Social Sciences (ARI) as a member of the Data Analysis Group (DAG), along with personnel from over 15 DoD agencies and organizations.

Mr. Hiss is to be acknowledged for his insights and recollections of historical events during Sgt York FOE I. His contribution provided an important foundation for this volume. Volume I was enhanced by the perceptions of Dr. Sally A. Seven and Mr. Douglass R. Nicklas who clarified issues and reviewed data. A very special acknowledgement goes to Dr. Frederick A. Muckler who made a significant contribution through his technical editing and review of two successive drafts. Mrs. Joan M. Funk merits special recognition for her technical assistance in preparing and editing the manuscript.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF TABLES (Cont.)

LIST OF FIGURES

I. EXECUTIVE SUMMARY

REQUIREMENT

The Sgt York Air Defense system Follow-On Evaluation I (FOE I) was conducted between 2 April 1985 and 15 June 1985. FOE I was divided into two phases, each at different locations. The Live Fire portion of the test was conducted at White Sands Missile Range, and the Force-on-Force portion of the test was conducted at Fort Hunter-Liggett. A unit was activated in October 1984 to prepare for and execute FOE I. Individual and collective training, as well as certification, were conducted at Fort Bliss.

During FOE I, the Sgt York Air Defense system was evaluated in a simulated operational environment. Various tactical scenarios were used during the Force-on-Force portion of the test. These scenarios were repeated for VULCAN to establish a performance baseline.

PROCEDURE

Sixty-eight human factors and safety deficiencies had been identified with the Sgt York Air Defense system prior to FOE I. A primary requirement for FOE I was the test and evaluation of human factors, training, and safety deficiencies. Human factors, safety, and training data were collected from five sources during FOE I: (1) 1553 Data Bus available on magnetic tape and computer printouts; (2) Video and audio tapes of Sgt York crew activities and communications; (3) Questionnaire responses from all player personnel; (4) Structured interviews and observations from player personnel; and (5) Test conductor event logs and Reliability, Availability, and Maintainability (RAM) data.

Five Sgt York fire units were used during the Live Fire phase. Two Sgt York systems were designated to fire during each aerial target scenario. A Sgt York platoon, four Sgt York fire units, and five Stinger companies were employed in support of an armor heavy battalion task force during the Force-on-Force phase. The battalion task force conducted a series of attack, delay, and tactical road march scenarios lasting about 20 minutes per trial.

FINDINGS

Human factors, safety, and training problems noted during FOE I were identified and clustered into twelve subcategories: (1) Physical Environment and Workspace; (2) Workspace, Anthropometrics, Comfort; (3) Controls and Displays; (4) Workload/Division of Labor; (5) Visibility; (6) Audio and Visual Alarms; (7) Target Detect/Acquisition/Tracking; (8) Communications; (9)

Travel/Navigation; (10) Publication/Documentation; (11) Safety; and (12) Training. When the seriousness of the impact was rated for the problem by subcategory, the average impact across all 12 categories would have predicted a prevention of optimal mission performance. Average ratings by subcategory indicated that there were four areas which were considered as seriously degrading mission performance. The subcategories identified were Physical Environment and Workspace, Workload/Division of Labor, Target Detect/Acquisition/Tracking, and Travel/Navigation. Findings indicated that redesign of the system and components would have improved the work environment and enhanced the system.

CONCLUSIONS

The findings of this research lead to the following general conclusions:

- Human factors, safety, and training design criteria were inadequately imposed on the design of the Sgt York Air Defense System.

- The weapon acquisition process was accelerated. This negatively influenced the resolution of human factors, safety, and training problems identified in previous DT/OT evaluations.

- Training efficiency and effectiveness for the FOE I tests were negatively impacted by the accelerated evaluation.

- Trials were constrained to intervals of 20-30 minutes due to the instrumentation used in data collection. As a result, the significance of human performance problems was underestimated.

- If operation had been sustained for 72 hours during FOE I, human factors, safety, and training problems seriously degrading combat system performance would have been certain.

II. INTRODUCTION

BACKGROUND

Forward Area Air Defense (FAAD) is responsible for the air defense of Army units in forward or combat areas. The FAAD mission is to defend ground combat forces, combat support forces, or any other related critical assets against attack or surveillance by airborne hostile forces. The FAAD mission is essential to overall air defense, and is integrated into the U.S. Army Air Defense Artillery (ADA) mission. FAAD directly supports the primary Army function of conducting prompt and sustained land warfare operations.

The DIVAD gun system (M247 Sgt York) was intended to provide all-weather, close range air defense for forward area mobile tactical units against hostile fixed-wing aircraft, helicopters, and lightly armored vehicles. The Sgt York was to operate as an integral part of combined arms teams. This weapon system was to be mobile and survivable enough to support front line armor, mechanized infantry, and armored cavalry units. Sgt York was to provide low altitude air defense against attacks by helicopters and high performance fixed-wing aircraft.

Test and evaluation of the Sgt York had been conducted since 1980. These tests were to verify the performance and reliability of the Sgt York Air Defense Gun System. Following is a list of tests previously conducted: (1) Division Air Defense Gun Developmental/Operational Combined Test (1981); (2) Developmental Test II A (1982); (3) Developmental Test II B (1983); and (4) Sgt York Limited Test (1984).

MILITARY PROBLEM

There were recurring human factors problems with the Sgt York Air Defense Gun System prior to FOE I. This weapon system was evaluated for safety and health, human factors engineering, aerial detection/tracking, aerial firing, multiple targets IFF, electronic countermeasures, ammunition capacity and system reload, and software. Sixty-eight safety and human factors deficiencies and shortcomings were identified with the Sgt York Air Defense Gun System from previous tests. Health hazards were identified which were associated with system design. Human factors findings suggested that, in addition to design problems, problems with this weapon system existed in the areas of air quality, NBC environment, workspace, reload, radar antenna, lighting, training manual, fire prevention, visibility, communication, environmental control unit, and target detection and acquisition.

Human engineering personnel were guided by MIL-STD-1472B, Human Engineering Design Criteria for Military Systems, Equipment and Facilities. However, the weapon system acquisition process for the Sgt York was accelerated throughout the life of the system. One of the fall-outs from the accelerated acquisition process was the limited preparation time available to develop test plans for operational and developmental testing.

The Vice Chief of Staff of the Army activated E Battery, 4th Battalion, 1st ADA as of October, 1984 to prepare for and execute the Follow-On Evaluation (FOE I) for the Sgt York Air Defense Gun. Individual and collective training was conducted, and certification was completed at Fort Bliss, TX.

Essex Corporation represented ARI as a member of the Data Analysis Group (DAG), along with personnel from over 15 DoD agencies and their contractors. Data collection, reduction, and analysis reflected requirements identified in the USAOTEA Draft Test Design Plan dated March 1985 for human factors, safety, and training.

PURPOSE AND SCOPE OF THIS TECHNICAL REPORT

The purpose of this report is to present the human factors, safety, and training results of the Sgt York Follow-On Evaluation (FOE I) which was conducted between 2 April 1985 and 15 June 1985. The FOE I was divided into two phases, each at different locations. The Force-on-Force phase of the FOE I was held at the Combat Development Experimentation Center (CDEC) at Fort Hunter-Liggett, CA. The Live Fire phase of FOE I was conducted at White Sands Missile Range, NM.

III. METHOD

GENERAL DESCRIPTION

During the Force-on-Force phase of FOE I, a Sgt York platoon (four Sgt York fire units, each with a 3-man crew) and five Stinger companies were employed in support of an armor heavy battalion task force comprised of two tank companies and one mechanized infantry company. There were 52 validated record trials, 29 Sgt York trials, 12 Vulcan baseline trials, and 11 trials with Chaparral/Vulcan combined (alternate systems). Stinger was present on all trials, as were two Chaparral fire units deployed to the rear of the battalion task force. The battalion task force conducted a series of attack, delay, and tactical road march scenarios lasting about 20 minutes (1 trial) against enemy ground vehicles and fixed- and rotary-wing aircraft. Trials were conducted under various electronic warfare conditions, under day and night conditions, and with and without nuclear, biological, and chemical (NBC) gear.

The Live Fire phase was conducted in the Red Rio area of White Sands Missile Range, NM between 22 May and 15 June 1985. Five Sgt York fire units were used during this phase, with two Sgt York systems designated to fire during each aerial target scenario. Prior to each trial, the fire units completed a 52-mile road march with a full load of ammunition over unimproved dirt roads with the system fully operational in all modes. The basic scenario consisted of two droned F-100 fixed-wing aircraft and one droned UH-1 helicopter. Six F-100s and three helicopters were destroyed by aerial fire in four trials. Chaparral engaged two rotary-wing drones. Sixty-one ground target engagements were conducted with stationary and moving M-114 and wheeled vehicle targets.

During FOE I, human factors, safety, and training data were collected from five sources for further reduction and analyses. Data were collected from five sources: (1) data from the 1553 Data Bus available on magnetic tape and subsequent computer printouts; (2) video and audio tapes of the Sgt York crew activities and communications during each mission; (3) questionnaire responses from all player personnel after the test; (4) structured interviews and observations from player personnel after each trial; and (5) a review of data collected by the Reliability, Availability, and Maintainability data collectors and a review of test conductor event logs.

SUBJECTS

The Sgt York battery was activated as Battery 3, 4th Battalion (C/V), 1st Air Defense Artillery on 16 October 1984 under Permanent Order 179-6 with personnel and equipment. The battery consisted of two Sgt York gun platoons and a headquarters element platoon. Crews used during FOE I were hand-picked from available personnel. The first platoon, crews 1-5, participated in Force-on-Force; the second platoon, crews 6-10, participated in Live Fire. Selected subjects for FOE I consisted of the following MOSs:

- o MOS 16L - Sgt York Air Defense Gun System Crewmember
- o MOS 24W - Sgt York Air Defense Gun Mechanic
- o MOS 224D Warrant Officer - Sgt York AD System Technician

MOS 27P, Sgt York Air Defense Gun System Repairer, and MOS 27Q, Sgt York Air Defense Gun System Test Specialist, were not available as subjects during FOE I. Direct support and general support maintenance was performed instead by personnel from Ford Aerospace and Communications Corporation (FACC).

Subjects assigned to MOS 16L who were selected for FOE I were obtained from three sources:

- o A Btry, 4th Bn (Vulcan) 1st ADA
- o Previous experience on Early Production Unit Test (EPUT) and Limited Test (LT) for the Sgt York Air Defense Gun System
- o Instructors, 1st Inst Bn (Prov), 1 ADA Trng Bde

A comparison between the Sgt York 16L MOS rank structure for E-4/1 versus the structure authorized in the TOE is shown in Table 1.

Table 2 describes the crewmembers assigned to MOS 16L who participated in the FOE I tests. The descriptive data contains crewmember position and rank, height, weight, Armed Services Vocational Aptitude Battery (ASVAB) subset scores for Operator/Foodhandler (OF) and Electronics (EL), as well as scores for Armed Forces Qualifications Test and Category (AFQT) (CT), General Test (GT), Training (individual and collective). Previous experience or lack of experience with the Sgt York Air Defense Gun System is also indicated.

Prerequisite experience and background required for 16L MOS personnel are specified below for the 16L10-OSUT (one station unit training) course and the 16L20/30/40-T (transition) course.

Table 1. SGT YORK E-4/1 16L RANK STRUCTURE AUTHORIZED VERSUS ASSIGNED FOR FOE I

POSITION	AUTHORIZED GRADE	AUTHORIZED TOE*	ASSIGNED E-4/1
Senior Sgt York Squad Leader	E-7	3	3
Sgt York Squad Leader	E-6	9	7
Sgt York Gunner	E-5	12	10**
Sgt York Driver	E-4	12	10***

*TOE assumes a 12 squad battery.
**Five - E-5; five - E-4.
***One - E-4; nine - E-2.

Table 2. SGT YORK FOE I GUN CREWS 16L MOS

CREW NUMBER	RANK	HEIGHT (INCHES)	WEIGHT (POUNDS)	ASVAB OF	ASVAB EL	AFQT	AND CAT	GT	TRAINING SCORES IND TNG	TRAINING SCORES COLL TNG	PREVIOUS SGT YORK EXPERIENCE
1.	SL E-7	69	130	118	106	23	IV	108	NA	SAT	Y
	GU E-5	73	210	105	93	19	IV	87	97.6	SAT	N
	DR E-2	66	151	98	86	30	IV	85	89.0	Note 1	N
2.	SL E-6	69	169	114	76	25	IV	84	91.3	SAT	N
	GU E-5	69	130	95	109	59	IIIA	96	Fail	SAT	N
	DR E-4	70	145	101	91	56	IIIA	99	Fail	Note 1	N
3.	SL E-6	72	195	112	113	65	II	118	NA	SAT	Y
	GU E-6	67	167	128	125	82	II	115	94.6	SAT	N
	DR E-2	73	184	97	87	26	IV	80	91.1	Note 1	N
4.	SL E-6	70	150	--	--	65	II	109	NA	SAT	Y
	GU E-6	74	215	119	120	65	II	110	97.2	SAT	N
	DR E-2	70	165	107	115	65	II	109	91.6	Note 1	N
5.	SL E-6	73	196	102	109	--	IIIA	99	96.7	SAT	N
	GU E-5	69	161	98	103	35	IIIB	80	94.9	SAT	N
	DR E-2	69	170	108	102	59	IIIA	106	92.1	Note 1	N
6.	SL E-7	70	160	116	125	68	II	125	96.3	SAT	N
	GU E-5	71	155	112	97	63	IIIB	104	97.0	SAT	N
	DR E-2	68	170	104	96	50	IIIA	96	93.8	Note 1	N
7.	SL E-7	69	160	--	90	70	II	120	NA	SAT	Y
	GU E-6	72	200	105	90	56	IIIA	103	Fail	SAT	N
	DR E-2	70	164	100	105	58	IIIA	103	97.2	Note 1	N
8.	SL E-6	66	135	--	--	80	II	120	NA	SAT	Y
	GU E-6	70	190	93	92	27	IV	94	93.0	SAT	N
	DR E-2	70	145	100	98	78	II	--	Fail	Note 1	N
9.	SL E-6	70	210	--	93	17	IV	106	96.8	SAT	N
	GU E-5	68	160	96	87	29	IV	96	NA	SAT	Y
	DR E-2	66	142	100	98	44	IIIB	97	91.2	Note 1	N
10. *	SL E-6	66	140	124	113	75	II	110	92.2	UNSAT	N
	GU E-6	67	150	84	70	19	IV	89	88.6	Note 1	N
	DR E-2	70	169	99	107	50	IIIA	100	Fail	Note 1	N

NOTES: Did not participate in Center Certification.
*Backup squad for Live Fire
OF - Operator/Foodhandler
EL - Electronics
ASVAB - Armed Services Vocational Aptitude Battery

AFQT - Armed Forces Qualifications Test Scores & Category
GT - General Test

Course	Prerequisites
16L10-OSUT	Active Army Grade E-4 and below Operator/Foodhandler score 95 or above Electrical score 90 or above
16L/20/30/40-T	Active Army Grade E-5 and above Related ADA MOS Operator/Foodhandler score 95 or above Electrical score 90 or above

Subjects selected for FOE I who had MOS 24W (Sgt York Air Defense Gun System Mechanic) and MOS 224D (Warrant Officer - Sgt York AD System Technician) were maintenance instructors in the SHORAD Department at Fort Bliss, TX. Comparative data are presented which describe the 24W MOS rank structure for E-4/1 and the structure authorized in the TOE as displayed in Table 3.

Prerequisite experience and background required for MOS 24W and MOS 224D are identified below. Active Army personnel had their first opportunity to provide organization maintenance on the Sgt York Gun System during FOE I.

MOS	Prerequisite
MOS 24W	Completion of 16L10 course Electronics score 105 or above Missile Maintenance (MM) score 100 or above
MOS 224D	Qualified Warrant Officer in related AD missile system (or equivalent background) (NCO) Selection by DA for Warrant Officer MOS 224D Completion of the Warrant Officer Entry Course (enlisted)

Scores from the ASVAB subtests operator/foodhandler and electronics, as well as scores from the Armed Forces Qualification Test and General Technical Test were compared for Sgt York crewmen and Vulcan crewmen (MOS 16R). As can be seen in Table 4, scores were slightly higher for the Sgt York crewmembers in most cases, with only three exceptions. These exceptions were for the Sgt York Gunner position on the AFQT and the GT, and the Sgt York Driver position on the GT.

DATA COLLECTORS

Data collectors were assigned to the human factors, safety, and training (HF/S/T) Data Analysis Group (DAG). They were trained in data collection and data reduction procedures by Essex Corporation and Combat Development Experimentation Center (CDEC) personnel. Training was conducted at Fort

Table 3. SGT YORK E-4/1 24W RANK STRUCTURE AUTHORIZED VERSUS ASSIGNED FOR FOE I

POSITION	AUTHORIZED GRADE	AUTHORIZED TOE*	ASSIGNED E-4/1
Chief York Air Defense System (YADS) Mechanic	E-7	1	2
Assistant Chief YADS Mechanic	E-6	1	3
Senior YADS Mechanic	E-5	2	2
YADS Mechanic	E-4	4	1

*TOE assumes a 12 squad battery.

Table 4. AVERAGE TEST SCORES FOR SQUAD LEADERS (SL), GUNNERS (GU), AND DRIVERS (DR) COMPARED TO THE POPULATION OF 16R CREWMEN

	SGT YORK			VULCAN
TEST	SL	GU (N=10)	DR (N=10)	16R (N=1281)
OF	114.8 (N=6)	103.7	101.4	100.0
EL	103.1 (N=8)	98.6	98.5	98.2
AFQT	54.2 (N=9)	45.4	51.6	45.4
GT	109.0 (N=10)	97.4	97.2 (N=9)	97.9

NOTES:
- OF - Operator/Foodhandler --- These are the two subtests from the Armed Services Vocational Aptitude Battery (ASVAB) that are currently used to select Vulcan crewmen.
- EL - Electronics
- AFQT - Armed Forces Qualification Test
- GT - General Technical

Hunter-Liggett, CA. Data collectors participated in the pretest activities to standardize their data collection and data reduction procedures. Training for data collectors included orientation to the Sgt York Gun System, use of data collection instruments, and reduction of data, i.e., video/audio tapes, and 1553 data bus printouts.

Throughout FOE I, data collectors documented incidents associated with safety, skills, training problems, and display and control inadequacies. Potential safety problems identified either by Sgt York crewmen or identified by data collectors were documented. This information was entered into the reliability and maintainability (RAM) data base maintained by personnel from White Sands Missile Range (WSMR).

During Force-on-Force exercises, four data collectors from CDEC collected data in the field by monitoring each trial via radio. Immediately after each exercise, they interviewed and debriefed each Sgt York crewmember on site. They recorded each significant incident and/or observation using an incident data sheet. RAM data collectors who were with the Sgt York 24 hours per day recorded observations relating to safety and maintenance. These observations were recorded on incident sheets, and followed up by human factors, safety, and training personnel.

Live Fire exercises had three data collectors assigned by Essex and WSMR. The data collectors debriefed the squad leader and gunner at the conclusion of each live fire exercise. Incident Data Sheets were completed for each significant incident.

Human factors personnel were responsible for the administration of questionnaires to subjects at the conclusion of four phases: (1) Collective Training, (2) Force-on-Force, (3) Live Fire, and (4) End of Test Questionnaire. Data were collected by members of HF/S/T DAG from five discrete sources.

DATA COLLECTION INSTRUMENTS

Data collection instruments included five categories: (1) 1553 Data Bus (data collected on magnetic tape). Subsequent printouts were supplied by White Sands Missile Range (WSMR) National Range. (2) Video/audio tapes of MOS 16L crewmen activities during missions. These tapes were used to evaluate crew workload and air defense activities associated with switch actions on the 1553 Data Bus computer printouts. (3) Questionnaires administered to Sgt York crewmembers during and at the completion of the test. (4) Structured interviews and observations administered and documented during and at the completion of the test. (5) RAM and Test Conductor/Controller event logs. Each of the five data collection categories will be described further and expanded upon.

1553 Data Bus. The Data Bus carried data from the Data System Controller (DSC), the Fire Control Computer, and the Radar Computer. Switch actions and other system events in the Sgt York also were carried on the Data Bus. The data on the Data Bus were recorded on magnetic tape and later reduced, using WSMR and contractor data reduction programs. Crew performance data were obtained from computer-generated printouts for missions conducted during FOE I Force-on-Force and Live Fire phases.

Video/Audio Tapes. Tape content consisted of verbal communications and nonverbal behavior among the gunner, squad leader, and driver. External communication between the Sgt York crewmembers and other relevant Army personnel was also recorded. Video/audio tapes were reviewed in conjunction with 1553 Data Bus computer printouts. Possible mission-related errors were investigated as well as crew workload, and command and control issues.

Questionnaires. Thirteen different questionnaires were developed. All questionnaires were administered to Sgt York crewmember subjects, and to key test directorate personnel. Questionnaires were administered prior to and during FOE I. Personnel operating alternate systems were also administered questionnaires. The objectives were to determine their experience and amount of training, and to obtain their assessment of the missions.

Observations and Post Mission Debrief. Sgt York data sheets were used by HF/S/T data collectors during the conduct of the test. Interviews, observations, or comments were recorded following missions, and at the completion of maintenance tasks. Sgt York Incident Data Sheets were completed when questionnaire items were rated with a strong negative response, and when sufficient amplifying data were not provided in the comment section on the questionnaire. Information from the Incident Data Sheets was entered into the RAM Data Base at Fort Hunter-Liggett and at White Sands Missile Range. Subjects debriefed included Sgt York crewmembers, rotary- and fixed-wing aircraft crewmembers, Blue Maneuver Force (M1, M3) and Red Maneuver Force (M60, M113) personnel, Stinger crewmembers, and other alternate system (Chaparral and Vulcan) crewmembers.

RAM and Test Conductor/Controller Logs. Logs and notes were recorded by the Test Conductor personnel during the test. This information was available to the DAG, and reviewed by the HF/S/T personnel daily to assist in identifying incidents. These logs and notes were used to assist in the analysis of human factors problems.

DATA ANALYSIS

The HF/S/T DAG was responsible for the review and analysis of all test data, creation of data bases, and identification, investigation, and documentation of system problems. Data Analysis Group (DAG) members maintained a master copy of data relating to human factors, safety, and training. Chief of the HFE DAG was responsible for the preparation of briefing material during the test, and reported test results to on-site TRADOC and Army Safety Center representatives. Data analysis for FOE I is described below for the 1553 Data Bus, Video/Audio Tapes, Questionnaires, Structured Interviews, and the RAM Data Base.

1553 Data Bus. Data from the 1553 Data Bus "Quick Look" (Auxiliary Output and Engagement Timeline) printouts were transposed to Data Sheets. This was performed for items required to analyze squad leader and gunner performance as they operated switches and monitored plasma displays. HF/S/T DAG members reviewed the 1553 Data Bus printouts.

Video/Audio Tapes. Content analysis was performed on the audio tapes to assess crew activities associated with target engagements, communications and workload (internal and external). Content analysis was conducted by generating transcripts for internal and external Sgt York crewmember communication. For each transmission, transcripts identified sender, receiver, start time, and stop time. The transcripts were coded according to content characteristics (target related, fault related, tactics, receipt of air defense warning changes, command and control characteristics).

Sgt York instructors assigned to the HF/S/T DAG reviewed video tapes for systems operations. Data displays were prepared to investigate behaviors that were associated with three different modes of operating. (1) Squad leader operating with his head out of the turret ("heads-out" condition). (2) Squad leader operating inside the crew compartment. (3) Behavior of the gunner when the squad leader is operating in a "heads-out" condition. Content analysis for the video tapes used a time-event sequence as a way to compare target engagements under the various conditions during the mission.

Questionnaires. Item-by-item analysis was performed for the responses to the questionnaires. Quantitative and qualitative analysis was performed. Subjects' comments were evaluated. Specific questionnaire items receiving unusual responses were further investigated through the use of interviews to investigate impacts on system performance.

Structured Interviews. Significant incidents associated with safety, skills, training problems, and display and control problems were documented by HF/S/T data collectors during FOE I. These problems were recorded on Incident Data Sheets as

reported by Sgt York crewmembers or by HF/S/T data collectors. Content from the Incident Data Sheets was entered into the RAM Data Base.

RAM Data Base. This data base was constructed to sort on any category from the listing on the Incident Data Sheets. The RAM Data Base printed out data in summary form. Mission debrief questionnaires, administered at the conclusion of each mission, were entered into the CDEC computer.

IV. RESULTS

The major interest of this research was to identify human factors, safety, and training problems associated with the Sgt York Air Defense Gun System. Results of the Sgt York Follow-On Evaluation (FOE I) are reported for the Force-on-Force phase and the Live Fire phase of this test.

FOE I results are reported by category. The data have been clustered into categories which are identified as follows: (1) Physical Environment and Workspace; (2) Workspace, Anthropometrics, Comfort; (3) Controls and Displays; (4) Workload/Division of Labor; (5) Visibility; (6) Audio and Visual Alarms; (7) Target Detect/Acquisition/Tracking; (8) Communications; (9) Travel/Navigation; (10) Publication/Documentation; (11) Safety; and (12) Training. The analysis presented for each category is a compilation of results obtained from the five areas of instrumentation previously described in Section III, Method, under Data Collection Instruments. These results are presented in table format and broken out by problem area, data source, crew number, system performance affected, and the seriousness of the impact. For the category of safety, hazard severity and hazard probability are also rated using MIL-STD-882. Each data collection instrument is identified according to a Data Source Key, along with the data source code:

Q - Questionnaire
I - Interview Debriefings
V - Crew Audio-Video
TSV - Thru-Sight Video
O - Observation by Human Factors Evaluators
B/P - 1553 Data Bus or Plasma Display

Safety problems are rated according to their degree of safety hazard severity, ranging from a rating of I (catastrophic -- death or system loss) to a rating of IV (less than minor injury, occupational illness, or system damage). Hazard probability is rated for safety problems on a scale ranging from A (Frequent - Continuously experienced) through E (Improbable - Unlikely to occur, but possible). Each problem identified by category and data source is rated by the degree of seriousness that impacts on mission performance. The impact may range from a rating of 1 (minor affect) through a rating of 5 (serious enough to prevent mission performance).

The following tables address the human factors, safety, and training problems identified during FOE I. In some instances, problems had been previously identified for the Sgt York Air Defense System, but had not yet been corrected. Where the human factors evaluation findings indicated that the problem still existed, this information will be reported by content for problem area, description of the fault, previous test

report where problem was identified, corrective action, and FOE I findings.

PHYSICAL ENVIRONMENT AND WORKSPACE

Data collected from questionnaires, interviews, and observations from all Sgt York crews established that crew compartments were crowded, hot, dirty, and noisy during tactical operations. This was rated as seriously degrading the mission performance. (See Table 5.)

WORKSPACE, ANTHROPOMETRICS, COMFORT

Current problems identified during FOE I included the browpad-face shield which was difficult for soldiers to keep their faces in for the gunsight and periscope, and the seat comfort of the driver, gunner, and squad leader. Seven Sgt York crews rated these problems. The impact was considered to degrade mission performance, but not to prohibit effective engagement. (See Table 6.)

Workspace problems identified during Developmental Test II A dealing with crewmember seats revealed that the problems still existed during FOE I. For example, driver and gunner seat padding were rated poor during DT II A. The driver's seat remained difficult to adjust except in the vertical direction, and it lacked a headrest.

During DT II A, gunners and squad leaders reported lack of knee and foot room. The driver's compartment provided minimal leg room for larger percentile drivers. Some crewmembers stated that their knees touched the steering wheel. There was no adequate workspace in the driver station for individuals above the 60th percentile. This was an inherent problem with the M48 chassis. The driver's compartment provided minimal space when the driver's hatch was closed. The driver was not able to look through the center of the vision blocks without the driver's helmet touching the hatch cover. It was determined that a malfunctioning seat mechanism also contributed to the head clearance problem during developmental testing, but at the time of FOE I, the problem continued to exist.

Another previously identified problem during DT II A was the lack of clearance between the driver's head and the turret during "heads-out" operation. This condition was to be corrected by procedures and training. The turret was to be locked while the driver was in a "heads-out" position. The driver was to be buttoned up when the turret was unlocked. This procedure was to be added to the training manual.

The squad leader continued to report physical discomfort during open-hatch operations. The latch in the squad leader's hatch was located even with the squad leader's back. The latch

Table 5. PHYSICAL ENVIRONMENT AND WORKSPACE

PROBLEM: Physical Environment and Workspace

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 FOF CREWS 6-9 LF

IMPACT SERIOUSNESS KEY:
1.-- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2.-- Degrades mission performance but normally does not prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5	
1. The crew compartments are crowded, hot, dirty, and noisy during tactical operations.	x	x			x		x	x	x	x	x	x	x	x	x	In particular, complaints from drivers were noted. Because of limited leg space (depending upon driver's size), some drivers had difficulty operating the brake pedal. Oil and dirt on boots and pedals exacerbated the problem. Discomfort and fatigue due to heat and cramping in the other compartments also were brought up. Crewmen also have reported problems with heat, sharp edges, and MOPP gear which may affect performance over times. Vibration and uncomfortable seats also have been mentioned repeatedly.				x		In general, large crew compartments, more efficient, reliable (ECU) cooling units, and more storage space would greatly improve the crew station environment. Also, a thorough anthropometric analysis of the driver's compartment (e.g., brake pedal, throttle, head clearance, shoulder space, etc.) should be conducted.

Table 6. WORKSPACE, ANTHROPOMETRICS, COMFORT

PROBLEM: WORKSPACE, ANTHROPOMETRICS, COMFORT

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 FOF CREWS 6-9 LF

IMPACT SERIOUSNESS KEY:
1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2 -- Degrades mission performance but normally does not prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW # 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS 1	2	3	4	5	REMARKS
Seat Comfort	X	X					X	X	X	X	X		X	X								
Driver has no back support when he leans forward into vision blocks.																Complaints of personal discomfort, which may interfere with effectiveness.						
Gunner and SL have no back support when they lean forward to look through sights.																						
Crewmember's complain of lack of padding on the seat.																						

Table 6. WORKSPACE, ANTHROPOMETRICS, COMFORT (Cont.)

PROBLEM:: Workspace, Anthropometrics, Comfort

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 FOF   CREWS 6-9 LF

IMPACT SERIOUSNESS KEY:

1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.

2 -- Degrades mission performance but normally does not prohibit effective engagement.

3 -- Prevents optimal mission performance. Effects can be minimized by additional training.

4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.

5 -- Very serious. Can prevent mission performance. Further procurement or fielding of SGT YORK should be canceled until this problem is eliminated.

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					RECOMMENDATIONS	REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5		
Brow Pad - Face Shield Difficult to keep face in gunsight and periscope.		X			X		X	X	X	X	X		X	X		Though this is only mentioned by two crewmembers, in debriefs, discussion with crews suggest they widely feel an improved brow pad needed.		X				Players recommend: 1. Face shield or brow pad attached to sights that crewmember can lay face and part of helmet into.	

dug into the back of the squad leader during open-hatch operations. This was not considered a major problem even though the condition persisted.

Entering and exiting the driver's compartment through the turret was identified as a problem during the Developmental Test (DT) II A. Ingress and egress through the turret took between 20 to 30 minutes. The 20 to 30-minute time to ingress and egress applied to the system when the turret was in the worst position. A 180-degree rotation was required, and the turret had to be rotated manually. This was an alternate option which was not primarily used by the driver. Drivers had three options for ingress/egress which were the driver's hatch, turret access, and a bottom escape hatch.

Emergency egress was evaluated in a separate test at the completion of FOE I. Findings from that test are presented in Table 7 for egress times for Sgt York crewmembers. Crewmembers were able to get out of the fire unit by their normal exits in less than 9 seconds regardless of the level of Mission Oriented Protective Posture (MOPP) gear worn or in their basic daily uniform (BDU).

Emergency egress was attempted through the underside hatch from the turret. Mean egress times in seconds are noted in Table 8 for the driver, second cremember, and third crewmember.

All three crewmembers attempted emergency egress through the driver's emergency hatch, but only one crew was successful. The emergency hatch was located under the driver's seat, and it was time-consuming to egress through the hatch. To enable the squad lead and gunner to egress through the driver's compartment required removal of the floor panel. The crewmembers had to lower themselves into the gunbay, and pass through the keyway into the driver's compartment. Egress through the gunbay was only possible when the turret was facing aft. The final exit was through the driver's emergency hatch.

Another problem cited during DT II A was associated with workspace and the stowage of NBC gear. FOE I findings indicated that the problem still existed. There was insufficient workspace within the vehicle to stow NBC gear. The crew would have had to stop the vehicle and climb out of their stations to retrieve NBC gear if an NBC attack took place. It took about 30 minutes to get into NBC gear while inside the vehicle.

Anthropometric data collected on the Sgt York driver's compartment are presented in Table 9.

Measurements of the driver's compartment were less than the requirements of MIL-STD-1472. Comments from a questionnaire completed by a driver stated, "Your head and legs catch hell when you are buttoned up. If you're a little tall, you've had it."

Table 7. MEANS AND STANDARD DEVIATIONS OF EGRESS TIMES FOR SGT YORK CREWMEMBERS IN SECONDS

CREW MEMBER	*BDU TURRET: FWD	*BDU TURRET: AFT	**MOPP-4 GEAR TURRET: FWD	**MOPP-4 GEAR TURRET: AFT	MEAN BDU	MEAN MOPP-4	MEAN TURRET: FWD	MEAN TURRET: AFT	MEAN TIME
Leader:									
mean	4.43	4.58	5.00	5.16	4.51	5.08	4.72	4.87	4.79
S.D.	.53	.56	.99	.76	.54	.87	.83	.72	.77
Gunner									
mean	4.36	5.13	5.98	5.67	4.74	5.82	5.17	5.40	5.28
S.D.	.84	1.40	1.27	.77	1.20	1.04	1.34	1.14	1.77
Driver									
mean	3.03	3.76	3.97	5.07	3.39	4.52	3.50	4.42	3.96
S.D.	.54	.71	.83	1.02	.72	1.07	.84	1.09	1.07
All									
mean	3.94	4.49	4.98	5.30	4.22	5.14	4.46	4.89	4.68
S.D.	.91	1.10	1.31	.88	1.04	1.12	1.24	1.07	1.17

*Basic Daily Uniform
**Mission Oriented Protective Posture

Table 8. MEAN EGRESS TIMES THROUGH THE UNDERSIDE HATCH IN SECONDS

Position	N	Mean	S.D
Driver	3	41.46	15.43
Second crewmember	1*	163.94	-
Third crewmember	1*	189.59	-

*3 crews attempted emergency egress through the underside hatch from the turrett. The first crew was unable to egress the vehicle because the gunner could not get past the machine gun mounting on the firewall with the floor panel pinned. The second crew unpinned and removed the floor panel to successfully egress through the underside hatch. Times for the third crew were invalid because the turret interior was not in its normal position at the start of the trial.

Table 9. ANTHROPOMETRIC DATA FROM SGT YORK DRIVER'S COMPARTMENT

1. SEAT WIDTH, ARMREST TO ARMREST........................18"
2. SEAT WIDTH, BETWEEN ARMRESTS..........................12.5"
3. HEADROOM (SEAT BOTTOM TO UNDERSIDE OF HATCH)..........32"
4. HEADROOM (SEAT BOTTOM TO CEILING).....................30.25"
5. BACK TO FRONT OF SEAT.................................13.25"
6. RADIUS OF SEAT..18"
7. HEIGHT OF SEAT BACK...................................11.5"
8. SEAT BACK TO STEERING WHEEL (HORIZONTAL)..............23"
9. SEAT TO FRONT OF COMPARTMENT..........................34"
10. SEAT FRONT TO FLOOR IN FRONT OF SEAT..................7"
11. SEAT FRONT TO LEFT PEDAL..............................16"
12. SEAT FRONT TO RIGHT PEDAL.............................17"
13. SEAT FRONT TO BOTTOM OF STEERING WHEEL (VERTICAL).....14.5"
14. BOTTOM OF STEERING WHEEL TO LEFT PEDAL................11.5"
15. BOTTOM OF STEERING WHEEL TO RIGHT PEDAL...............15.5"
16. WIDTH OF LEFT PEDAL...................................6"
17. WIDTH OF RIGHT PEDAL..................................8.5"
18. SEPARATION BETWEEN PEDALS.............................2"
19. SEPARATION BETWEEN TOP OF STEERING WHEEL AND DASH.....2"
20. TOP OF VISION BLOCKS TO BOTTOM OF HATCH...............4"
21. HATCH, SIDE CLEARANCE.................................24.5"
22. HATCH, FRONT TO BACK CLEARANCE........................15"
23. KEYWAY OPENING WIDTH..................................29.5"
24. KEYWAY OPENING HEIGHT.................................22"

Data collected by the Army Research Institute, Ft. Bliss, TX.

In addition to the driver's compartment having less than adequate workspace, the turret compartment provided only minimal workspace for the squad leader and gunner. Crewmembers complained of being cramped. They suffered bruises on their knees from continually hitting the instrumentation panel while slewing the turret or while the system was traveling over rough terrain.

CONTROLS AND DISPLAYS

The category of Controls and Displays indicated that there were four basic problem areas: distracting alarms, visual displays which were difficult to decipher, location and integration of controls, and glare on the plasma display. The most serious of these problems rated as having an impact that would prevent optimal mission performance was the glare on the plasma display. Data sources used were questionnaires, interviews and debriefings, and crew audio-video. (See Table 10.)

WORKLOAD/DIVISION OF LABOR

During Force-on-Force, the work overload for the squad leader position also impinged on the gunner position. The workload problems were identified through data sources of questionnaires, crew audio-video, and the 1553 Data Bus or Plasma Display. All workload problems were rated as seriously degrading mission performance, and frequently or always degrading effective target management. (See Table 11.)

VISIBILITY

Results from questionnaires, interviews/debriefings, and observations by human factors evaluators indicated visibility problems with the driver's compartment. These problems had been previously identified during DT II A. The driver had a limited view through the vision blocks when driving in the hatch-closed position. The driver had an interrupted field of vision since there was no vision overlap between the three vision blocks. This problem is inherent to the M48A chassis. The squad leader had to provide visual assistance to the driver by viewing through the 360-degree periscope. This contributed to the workload of the squad leader. This problem was rated as seriously degrading mission performance. (See Table 12.)

Other vision problems identified for all three crewmembers were associated with night visibility. The impact was rated between "degrades mission performance, but normally does not" and "seriously degrades mission performance." (See Table 12.) Data sources for rating night visibility were obtained from questionnaires and interviews/debriefings.

Table 10. CONTROLS AND DISPLAYS

PROBLEM: Controls and Displays

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

IMPACT SERIOUSNESS KEY:

1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2 -- Degrades mission performance but normally does not prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

CREWS 1-5 FOF CREWS 6-9 LF

Dash (-) indicated that this was not measured or not applicable for these crews

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5	
Displays: Some of the alarms are distracting and interfere with communication. Some visual displays are difficult to read, especially when exposed to sunlight.	x	x					x	x	x	x	x	-	-	-	-	The distractions and interference associated with auditory displays have on some occasions made communications difficult. Also, "washout" from sunlight could make display-reading difficult or impossible during heads-out operation.		x				Some specific recommendations by crewmen mentioned are: - need for variable volume and display brightness controls. - communication control on control grip. - a means of stabilizing the squad leader's control grip when he is in the heads-out position.
Controls: A few issues have surfaced regarding control location, integration, and ease of operation.	x	x					x	x	x	x	x		x	x		Difficult to operate controls (e.g., brake pedals) pose obvious dangers. Also, separate controls requiring operation by the same crewmen increase workload and decrease efficiency.		x				
Glare on Plasma Display: When the SL's hatch is open, you get glare on the display partially or totally interfering with seeing the display.	x	x	x				x				x					Ability to put pointer on targets is slowed down.			x			Players recommend: sunscreen for the display.

Table 11. WORKLOAD/DIVISION OF LABOR

PROBLEM: WORKLOAD, DIVISION OF LABOR

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 FOF CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or applicable for these crews.

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PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW # 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS 1	2	3	4	5	REMARKS
Squad Leader's Workload	X		X			X	X	X	X	X	X	-	-	-	-	Data source - may be from meetings with performance - Were there missed engagements because SL was out of hatch directing driver?					X	
1. If driver is buttoned-up, he cannot see well enough to drive without SL's instructions. Thus SL goes out of hatch to direct driver. At the same time, he must handle all external commo and detect and approve targets.																						1. SL switch allowing him to cage the periscope to the hull. Additional alternative recommendation: 2. Have the cue for hull orientation inside the periscope so SL can quickly access same view while staying in periscope.
2. When SL is out of hatch, gunner must track, monitor display and push the alarm reset button.																						Reduction in SL navigational responsibilities.

Table 11. WORKLOAD/DIVISION OF LABOR (Cont.)

PROBLEM: WORKLOAD/DIVISION OF LABOR

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
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CREWS 1-5 FOF CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:

1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
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PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW # 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS 0	1	2	3	4	5	REMARKS
The possibility of overload has arisen in respect to communications and "heads-out" operations by the squad leader.	x		x			x	x	x	x	x	x	-	-	-	-	During Force-On-Force operations, in particular, there were comments about squad leaders being overtaxed by the simultaneous monitoring of communication nets and performing tactical tasks. Also, squad leaders heads out operation to facilitate navigation and/or target acquisition may possibly degrade the squad leader-gunner tactical interaction.					x		Reduction in squad leader navigational and communications responsibilities would be beneficial. Some of the existing problems are due to difficulties associated with the communications load/controls and driver vision, discussed elsewhere) (See Communications and Travel).

Table 12. VISIBILITY

PROBLEM: Visibility

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 POF CREWS 6-9 LF

Dash (-) indicated that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:
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PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5	
Driver's compartment visibility When buttoned-up and relying on the vision blocks, the driver can't see upwards or downwards and there are blind spots to the side, between the vision blocks. He can see out the front only at a distance. This is particularly limiting when going up and down hills. Going up, he can only see the sky. Going down, he can only see out several feet ahead of the track.	X	X			X		X	X	X	X	X	X			X	Driver's inability to see increases the workload of the squad leader who must direct him. It also increases crew stress -- crewmembers know the driver may not see obstacles in the way. Drivers report that they drive slower than capable due to limited vision. 2 crewmen received injuries when SY vehicle ran into a ditch. 2 SY's had bent gun barrels after hitting trees. Radars were damaged due to tree limbs.				X		Player recommendations: 1. Training - increase navigation training while SL & D buttoned-up. 2. Equipment - one continuous wrap-around vision block. 3. Pressure sensors to track and search antennas which would stow them before a collision occurred. Note 1: This problem was identified in DT II A, 1982.

Table 12. VISIBILITY (Cont.)

PROBLEM: Visibility

DATA SOURCE KEY:
Q -- Questionnaires
I -- Inverview/Debriefings
V -- Crew Audio-Video
TSV - Through Sight Video
O -- Observation by Human Factors Evaluators
B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 FOF . CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:

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PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW # 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS 1	2	3	4	5	REMARKS
Night Visibility:																						
1. Goggles and imaging device in driver compartment inadequate.		X					X	X	X			-	-	-	-	Data source: Amount of time SL spends navigating during night tirals may be a data sources.				X		Players recommend thermal sights for driver and crew compartments. Cab lighting compatible with whichever NVGs are used. Use of PNV-Gs which can be raised and lowered more easily and are more comfortable to wear. Note 1. During the first night trial (1037) driver drove system into a hole in road which he did not see. All 3 crewmembers received minor injuries.
2. SL had to devote majority of his time to directing driver from heads-out position.	X						X	X	X	X	X	-	-	-	-					X		
3. Incompatibility of cab lighting with NVGs made it difficult for SL to see both in cab and head out.		X					X					-	-	-	-			X				
Field of view on SL's periscope		X					X	X	X	X		-	-	-	-	There are several instances of gun barrel swinging into trees and antennas hitting trees			X			Players recommend wider FOV and more magnification. However, one can't be increased without decreasing the other. Note 1. If SL did not need to direct the driver (navigate) FOV might be considered more satisfactory.
Dust and mud on driver's vision blocks and mud and water entering driver's compartment.		X					X	X	X	X	X	-	-	-	-			X				Players recommend skirts and splashguards.

AUDIO AND VISUAL ALARMS

Problems were identified with the engageable target alarm and the alarm reset button. They were rated as degrading mission performance, but would not normally prohibit effective engagement. (See Table 13.)

TARGET DETECT/ACQUISITION/TRACKING

Visual problems were identified in target detection, acquisition, and tracking. They were rated as preventing optimal mission performance. Misidentification of aircraft with the IFF system was identified through data sources of questionnaires, interviews/debriefings, and the 1553 Data Bus or Plasma Display. (See Table 14.)

Table 15 presents summary data, across all 29 valid FOE I Force-on-Force trials and across all fire units, on target pointing actions and on target acquisitions. The 2,763 radar pointer actions included in Table 15 represent the pointings which resulted in target designations. Target acquisition data are included for these radar pointer acquisitions, as well as for 360 other designations, 59 of them radar auto designations.

As shown in Table 15, the average time from designation to breakoff for 3,123 designations across all modes was 10.9 seconds. Radar pointer designations, whether by squad leader (9.8 seconds) or gunner (10.5 seconds), were faster than the average. Laser designations were slower; the average laser designation (squad leader or gunner designations combined) took 14.8 seconds. For the 6 laser designations by squad leaders, the average time was 12.6 seconds; for the 178 by gunners, the average time was 14.9 seconds. Squad leader slave designations averaged 27.4 seconds across 117 instances. (The slave designation denotes which operator is in control.) Table 15 also shows the length of lasings. Data are provided for squad leader, for gunner, and averaged across both crewmembers.

The 3,123 target acquisitions are also broken down in Table 15 by target that was acquired, by breakoff method used, and by reason for breakoff. Note that in 1,960 cases (62.8%), the reason for the breakoff was "no contact." That is, no target was found.

Times from designation to breakoff in cases for which trigger pulls occurred were on the average 1.16 seconds longer than in those where trigger pulls did not occur. Over the 29 valid Force-on-Force trials, and over all participating Sgt York fire units, a total of 8,224 radar-pointer actions were initiated. From all those radar-pointer actions, 2,763 radar-pointer designations resulted. Thus, on the average, there were 2.98 radar-pointer actions initiated for each radar-pointer designation that occurred. Multiplying this figure by the mean time from pointer switch depress to pointer switch

Table 13. AUDIO AND VISUAL ALARMS

PROBLEM: Audio and Visual Alarms

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 POF CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:
1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
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PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW # 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS 1	2	3	4	5	REMARKS
Engageable target alarm and alarm reset button.																The loudness of the alarm breaks crew concentration during tactical operations. The alarm reset button places greater task load on the crew.						
1. Engageable target alarm is too loud, often interfering with commo.	x	x						x			x	x	x	x	x			x				Alarm - provide volume control. Alarm needs automatic shut-off activated after several seconds.
2. Alarm reset button should be relocated. Currently it requires G or SL to remove hand grips to reset it.		x									x							x				Reset button - if no automatic shut-off, relocate alarm reset to be a switch that either SL or G can reach easily, two switches (1 for SL, one for G) or two switches one for SL in hatch, 1 for SL out of hatch).
3. When SL is heads-out, it is a long reach for G to hit reset button.	x												x					x				

Table 14. TARGET DETECT/ACQUISITION/TRACKING

PROBLEM: TARGET DETECT/ACQUISITION/TRACKING

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 POF
CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:

1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2 -- Degrades mission performance but normally does not. prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5	
1. Visual problems in target detection, acquisition, and tracking involve effects of smoke; dust; and sighting problems while on the move.	x	x		x			-	-	-	-	-	x	x	x		In Live Fire, targets were somes times obscured by dust/smoke, especially during long burst schedules. In addition, laser return was degraded by dust and smoke. Also, comments and observations indicate that the motion/instability induced during operations on the move create a difficult gunner-browpad interface. In this regard, lasing on the move reportedly is extremely difficult.			x			A means of stabilizing/making integral the operator-browpad interface should be explored. Any factors which influence motion & vibration in the gunner's and squad leader's compartments also should be investigated.

Table 14. TARGET DETECT/ACQUISITION/TRACKING (Cont.)

PROBLEM: Target Identification/Classification

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 FOF . CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:

1.-- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2.-- Degrades mission performance but normally does not prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5	
Mis-identification of aircraft via the IFF system is of concern among SGT YORK crewmen	x	x				x	x	x	x	x	x	-	-	-	-	During the Force-On-Force trials:						
																- 4 of 5 squad leaders said that aircraft had been mis-identified with IFF. 3 A7s had been identified as friendly. An F4 had given alternating friend-hostile-friend signals.				x		
																- 2 of 5 squad leaders stated that friendly aircraft (apparently helicopters) were engaged.					x	
																- 2 of 5 gunners mentioned IFF problems.				x		

Table 15. FIRE UNIT SUMMARY DATA FOR ALL TRIALS, ACROSS FIRE UNITS (all times in seconds)

	MIN	MAX	RANGE	MEAN	STD. D.	N
TARGET POINTING DATA:						
TIME FROM PTR SWITCH DEPRESS TO PTR SWITCH RELEASE	0.045	12.816	12.771	1.529	1.179	2763
TIME FROM POINTER SWITCH RELEASE TO DESIGNATION	0.000	50.475	50.475	2.140	3.010	2763
TARGET ACQUISITION DATA:						
TIME FROM ACQUISITION TO BREAKOFF:						
OVERALL	0.022	137.401	137.379	10.943	10.137	3123
RADAR AUTO DESIGNATIONS	0.113	48.941	48.828	8.836	9.510	59
OTHER DESIGNATIONS	0.022	137.401	137.379	10.983	10.146	3064
RADAR POINTER	0.022	65.899	65.877	10.032	8.726	2763
BY SQUAD LEADER	0.022	65.899	65.877	9.786	8.656	1787
BY GUNNER	0.022	59.127	59.105	10.484	8.839	976
LASER	0.136	58.973	58.837	14.807	12.656	184
BY SQUAD LEADER	4.840	22.678	17.838	12.612	6.648	6
BY GUNNER	0.136	58.973	58.837	14.881	12.814	178
SQUAD LEADER SLAVE	0.659	137.401	136.742	27.423	18.306	117
TARGET LASING DATA:						
LENGTH OF FIRST LASING	0.010	59.546	59.536	2.574	4.937	424
BY SQUAD LEADER	0.091	2.817	2.726	1.191	0.881	20
BY GUNNER	0.010	59.546	59.536	2.642	5.044	404
LENGTH OF LAST LASING	0.136	13.269	13.133	2.214	2.608	38
BY SQUAD LEADER	0.363	0.363	0.000	0.363	**********	1
BY GUNNER	0.136	13.269	13.133	2.264	2.625	37

TARGET ACQUIRED (IMAGE IN GUNSIGHT VIDEO):	# OCC.
NONE	2019
UNCLASSIFIABLE	209
FRIENDLY FIXED WING (F4, A6)	76
HOSTILE FIXED WING (A7, A10)	491
FRIENDLY ROTARY WING (AH-1)	95
HOSTILE ROTARY WING (AH-64)	49
NO VIDEO	184

BREAKOFF METHOD:	
BREAKOFF	1452
FRIEND	143
SLAVE	983
POINTER DESIGNATE	205
AUTO DESIGNATE	7
FCC	201
OTHER / UNKNOWN	132

REASON FOR BREAKOFF:	# OCC.
NO CONTACT	1960
TARGET MASKED	253
VISUAL ID FRIEND	197
LOST TARGET (OTHER THAN MASK)	70
NO RADAR OR LASER CUE	4
NO FIRE SOLUTION	28
KILLED TARGET	88
DEPLETED AMMO	0
BROKE TO REACQUIRE TARGET	34
TARGET OUTBOUND AND/OR OUT OF RANGE	107
IFF FRIEND (BREAKOFF BY FCC)	6
ARM ALERT (BREAKOFF BY FCC)	3
NO SEARCH FILE (BREAKOFF BY FCC)	29
SYSTEM WENT TO NON-ACQ. MODE, REASON UNK.	30
CREW BROKE OFF, REASON UNK.	289
OTHER	25

release shown in Table 15 (1.5 seconds for the 2,763 cases in which radar-pointer designations were made) gives an average of 4.5 seconds of display-pointer activity preceding a radar-pointer designation, which lasts an average of 10.0 seconds. Since display-pointer activity can occur simultaneously with an engagement, it does not necessarily add any time to the engagement. The mean time from pointing the target on the display to designating it was 2.1 seconds.

As shown in Table 15, the average engagement duration from designation to breakoff was 10.9 seconds (for 3,123 designations in all modes). Thus, the Sgt York fire unit crew could have handled an average of 5.5 designations per minute. Table 16 shows, by mode, data on engagements that reached the stages of designation, then fire enable, and finally fire enable plus trigger pull. Of 1,502 designations analyzed, 26.4% (396/1502) proceeded through the engagement sequence to the point of fire enable with trigger pull. If 26.4% of the 5.5 designations per minute resulted in firings, it would mean that 1.45 targets per minute would have been fired upon, on the average. These times were similar regardless of the kind of ECM environment.

As shown in Table 15, in the 59 cases (1.89% of total) in which the radar auto mode was used, the duration of engagements was 2.1 seconds less for radar auto designations overall. However, as Table 16 shows, productivity (number of targets fired upon) for auto designations was only 20% (2/10), compared with 26.4% (396/1502) for all modes combined. Conversely, Table 15 indicates that laser designations took slightly longer (14.8 seconds) and squad leader slave designations almost twice as long (27.4 seconds). Table 16 indicates that productivity was considerably higher for these modes (24.2%; 137/401, for all optical designations). Therefore, the increased time required by the slower engagement modes (laser and squad leader slave) was largely offset by their greater productivity, so that the rate of engagements carried to the point of firing on the targets was not very different for the various engagement modes. As Table 16 shows, half of the radar auto designations that reached fire enable were actually fired upon (2/4). Over two-thirds of the radar-pointer designations were fired on (257/ 370). Almost 80% of the optical designations were fired on (137/173).

Crewmembers were trained to use the left trigger when firing on a target because using the right hand trigger was apt to interfere with the aim of the gun. Table 17 presents data to indicate how successful that training was. As Table 17 indicates, 1,539 trigger actions were analyzed to determine which crewmember (gunner or squad leader) fired and which trigger he used. In 1,102 cases, neither crewmember used either trigger. That is, the target was not fired on. In 410 cases, the gunner used his left trigger and the squad leader took no action. In other words, in 95% of the cases in which a target was fired on (410 of 430), the policy of having the

Table 16. DESIGNATIONS, FIRE ENABLES, AND TRIGGER PULLS BY ACQUISITION MODE

MODE	DESIGNATION	FIRE ENABLE	FIRE ENABLE & TRIGGER PULL
RADAR AUTO	10	4	2
RADAR POINTER	1091	370	257
OPTICAL	401	173	137
TOTAL	1502	547	396

Table 17. TRIGGER PULLS ACROSS ALL FIRE UNITS AND ALL FORCE-ON-FORCE TRIALS

	Gunner			
	No Trigger Pulls	Left Trigger	Right Trigger	Totals
Squad Leader				
No Trigger Pulls	1102 71.60%*	410 26.64%	10 0.65%	1522 98.90%
Left Trigger	9 0.58%	6 0.39%	0 0.00%	15 0.97%
Right Trigger	1 0.06%	1 0.06%	0 0.00%	2 0.13%
Totals	1112 72.25%	417 27.10%	10 0.65%	1539 100.00%

*Percentage of the total (1,539)

gunner do the firing and having him use his left trigger was followed. In 10 other cases, the gunner used his right trigger. In another 10 cases, it was the squad leader who did the firing, 9 of them using his left trigger and 1 using his right. In 7 cases, both the gunner and the squad leader fired; in 6 of those cases, both crewmembers used their left triggers, and in 1, the squad leader used his right.

Table 18 presents information on all designations in which intervisibility continued for at least 5 seconds after the time at which designation occurred. (Intervisibility is the segment of time during which the target was visible.) A given target might be visible at several different times, masking in between. An intervisibility duration applies to a single appearance; it is not cumulative. As may be seen by comparing the entries in Table 17 (which show trigger pulls for all targets, regardless of length of intervisibility duration) with those in Table 18 (which are limited to trigger pulls on targets for which the intervisibility duration was more than 5 seconds), in 97% of the cases in which either the squad leader, the gunner, or both pulled the trigger, it was for targets available for at least 5 seconds following designation.

$$\frac{\text{From Table 18} \quad 399 + 10 + 9 + 5 + 1 + 1}{\text{From Table 17} \quad 410 + 10 + 9 + 6 + 1 + 1} = \frac{425}{437} = .97$$

As Figure 1 indicates, in the case of hostile rotary-wing aircraft, almost 50% of the intervisibility segments lasted 4 seconds or less. Because of crew reaction and turret slew times, it is possible that if any of these targets were designated, the target would have masked before the slew was complete.

As shown in Figure 2, for the distribution of durations from the start of intervisibility to designate for correlated targets, only 11.54% of the cases were hostile rotary-wing aircraft. They were designated within 1 second of start intervisibility. It is unlikely that extremely short segments would have been designated at all.

As shown in Figure 3, after the start of intervisibility, 76% of the hostile rotary-wing aircraft were displayed within 4.0 seconds. Over 56% of the hostile rotary-wing aircraft were displayed in less than 1.0 second. There were a large number of short-duration hostile rotary aircraft intervisibility segments. A great proportion of intervisibility segments would have been on the verge of ending when the target was first displayed. This was substantiated by data which indicated that 48% of in-range targets were displayed for less than 5.0 seconds plus flight time.

As shown in Figure 4, over one-third of the durations between designate and end of intervisibility were 4.0 seconds or less for hostile rotary-wing aircraft targets. Thus, these

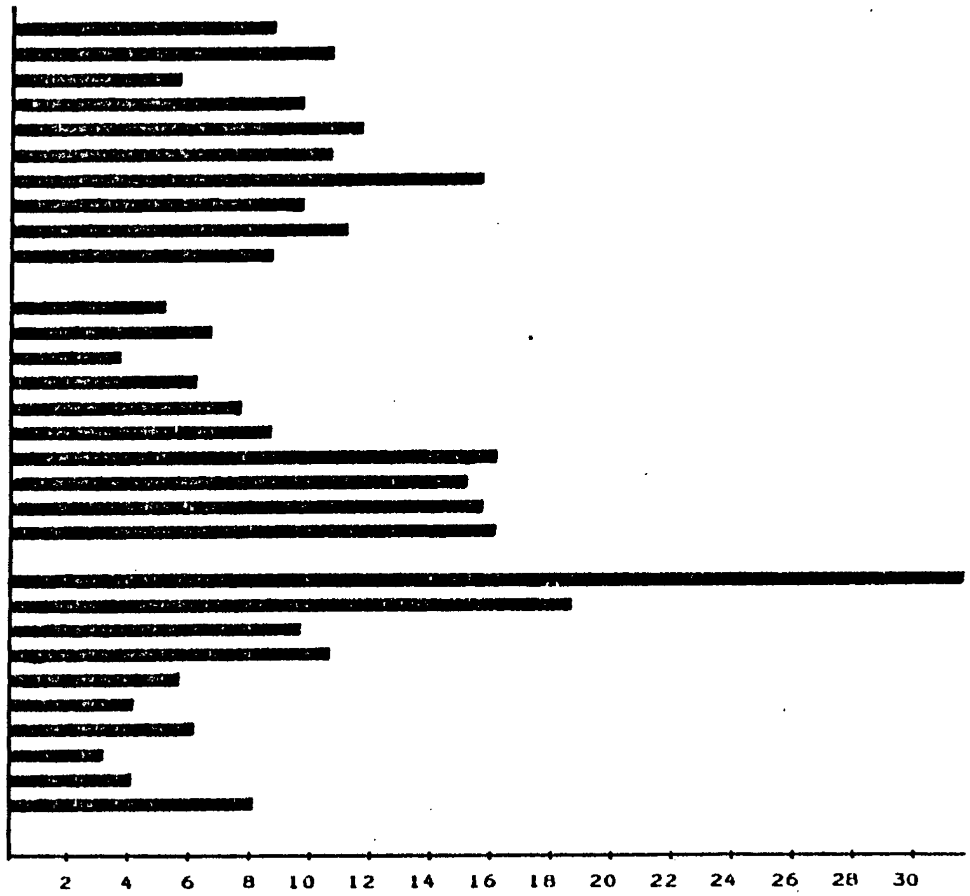
Table 18. TRIGGER PULLS FOR INTERVISIBILITY SEGMENTS LASTING MORE THAN FIVE SECONDS FOLLOWING DESIGNATION ACROSS ALL FIRE UNITS AND ALL FORCE-ON-FORCE TRIALS

	Gunner			
	No Trigger Pulls	Left Trigger	Right Trigger	Totals
Squad Leader				
No Trigger Pulls	759 64.10%*	399 33.70%	10 0.84%	1168 98.65%
Left Trigger	9 0.76%	5 0.42%	0 0.00%	14 1.18%
Right Trigger	1 0.08%	1 0.08%	0 0.00%	2 0.17%
Totals	769 64.95%	405 34.21%	10 0.84%	1184 100.00%

*Percentage of the total (1,184)

Figure 1. Distribution of Intervisibility Durations for Targets That Were Displayed. Summary Over All the Trials.

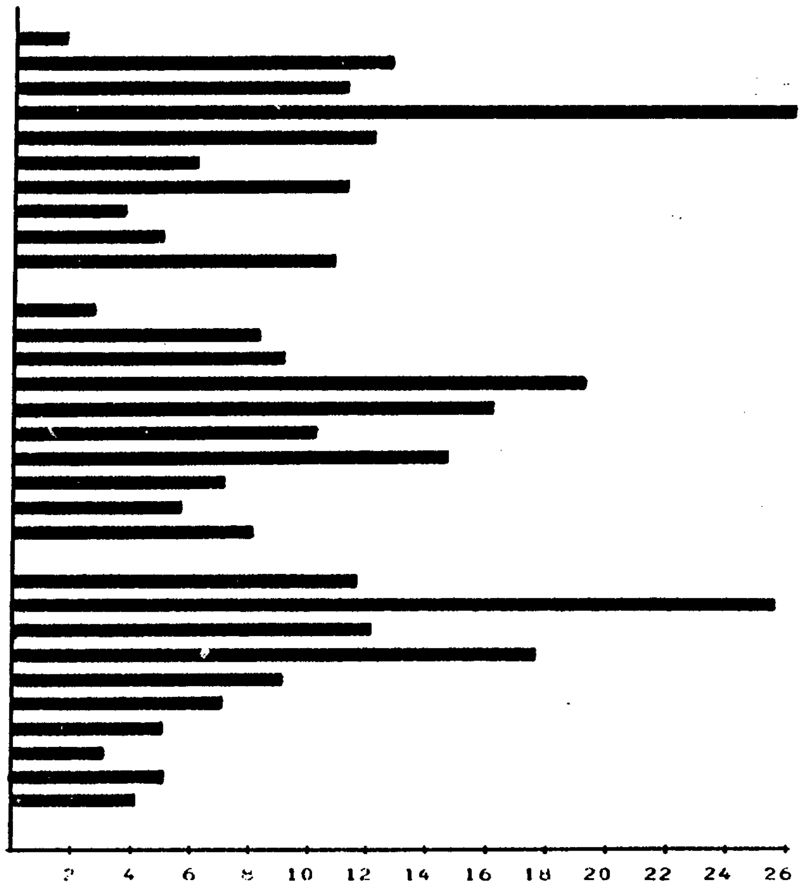
PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	0:<1	72	72	8.71	8.71
	1:1-4	86	158	10.40	19.11
	2:4-6	44	202	5.32	24.43
	3:6-10	78	280	9.43	33.86
	4:10-15	96	376	11.61	45.47
	5:15-20	85	461	10.28	55.74
	6:20-30	128	589	15.48	71.22
	7:30-40	77	666	9.31	80.53
	8:40-60	90	756	10.88	91.41
	9:>60	71	827	8.59	100.00
HOSTILE FIXED	0:<1	54	54	4.85	4.85
	1:1-4	73	127	6.56	11.41
	2:4-6	40	167	3.59	15.00
	3:6-10	68	235	6.11	21.11
	4:10-15	84	319	7.55	28.66
	5:15-20	96	415	8.63	37.29
	6:20-30	178	593	15.99	53.28
	7:30-40	166	759	14.91	68.19
	8:40-60	174	933	15.63	83.83
	9:>60	180	1113	16.17	100.00
HOSTILE ROTOR	0:<1	167	167	31.27	31.27
	1:1-4	99	266	18.54	49.81
	2:4-6	51	317	9.55	59.36
	3:6-10	55	372	10.30	69.66
	4:10-15	29	401	5.43	75.09
	5:15-20	21	422	3.93	79.03
	6:20-30	31	453	5.81	84.83
	7:30-40	16	469	3.00	87.83
	8:40-60	21	490	3.93	91.76
	9:>60	44	534	8.24	100.00

Figure 2. Distribution of Times from Start Intervisibility to Designate for All Engagements of Correlated Targets. Summary Over All Trials.

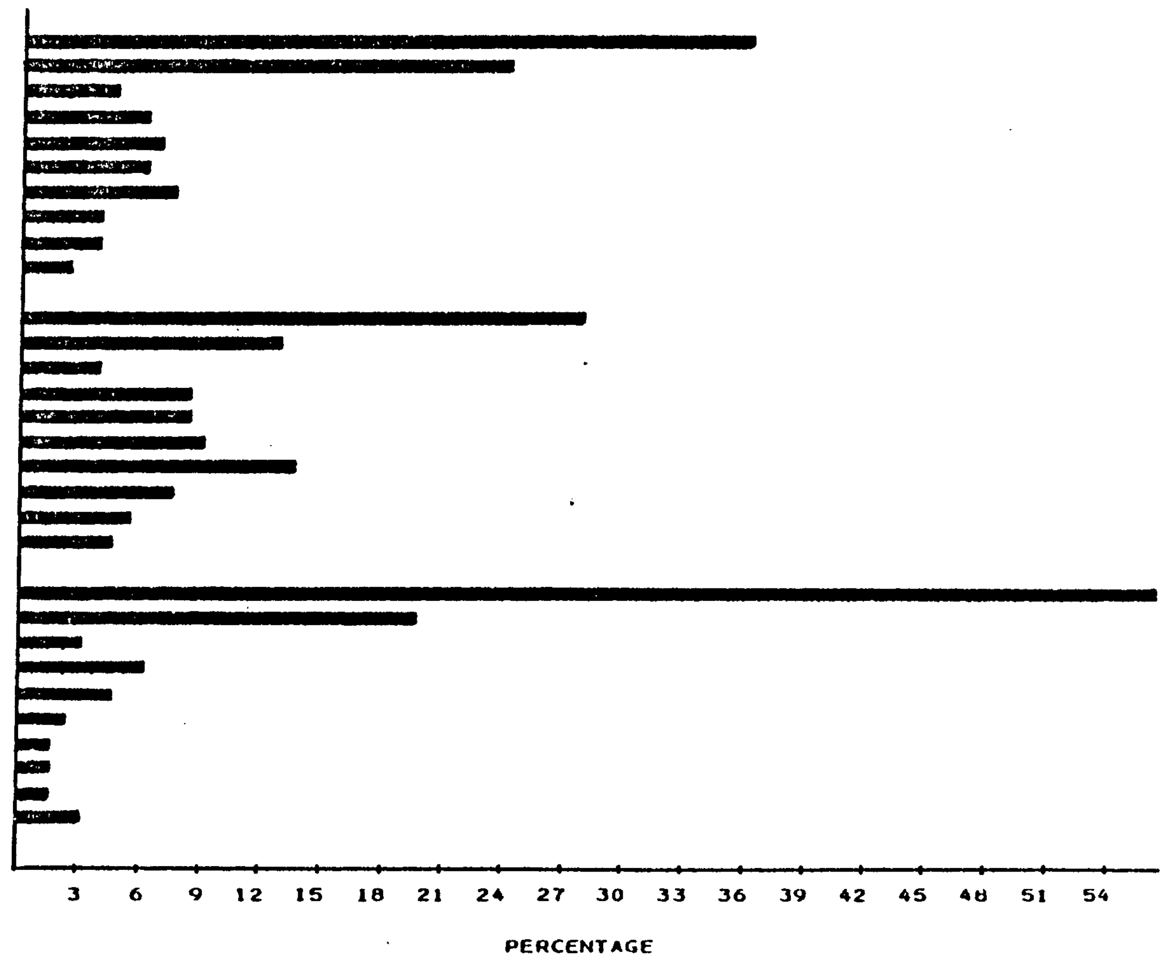
PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	<1 SEC	2	2	1.49	1.49
	1 TO 4 SEC	17	19	12.69	14.16
	4 TO 6 SEC	15	34	11.19	25.37
	6 TO 10 SEC	35	69	26.12	51.49
	10 TO 15 SEC	16	85	11.94	63.43
	15 TO 20 SEC	8	93	5.97	69.40
	20 TO 30 SEC	15	108	11.19	80.60
	30 TO 40 SEC	5	113	3.73	84.33
	40 TO 60 SEC	7	120	5.22	89.55
	>60 SEC	14	134	10.45	100.00
HOSTILE FIXED	<1 SEC	14	14	2.64	2.64
	1 TO 4 SEC	42	56	7.92	10.57
	4 TO 6 SEC	48	104	9.06	19.62
	6 TO 10 SEC	101	205	19.06	38.68
	10 TO 15 SEC	86	291	16.23	54.91
	15 TO 20 SEC	54	345	10.19	65.09
	20 TO 30 SEC	77	422	14.53	79.62
	30 TO 40 SEC	36	458	6.79	86.42
	40 TO 60 SEC	29	487	5.47	91.89
	>60 SEC	43	530	8.11	100.00
HOSTILE ROTOR	<1 SEC	18	18	11.54	11.54
	1 TO 4 SEC	40	58	25.64	37.18
	4 TO 6 SEC	19	77	12.18	49.36
	6 TO 10 SEC	27	104	17.31	66.67
	10 TO 15 SEC	14	118	8.97	75.64
	15 TO 20 SEC	11	129	7.05	82.69
	20 TO 30 SEC	8	137	5.13	87.82
	30 TO 40 SEC	5	142	3.21	91.03
	40 TO 60 SEC	8	150	5.13	96.15
	>60 SEC	6	156	3.85	100.00

Figure 3. Distribution of Times from Start Intervisibility to First Display for All Displayed Targets. Summary Over All Trials.

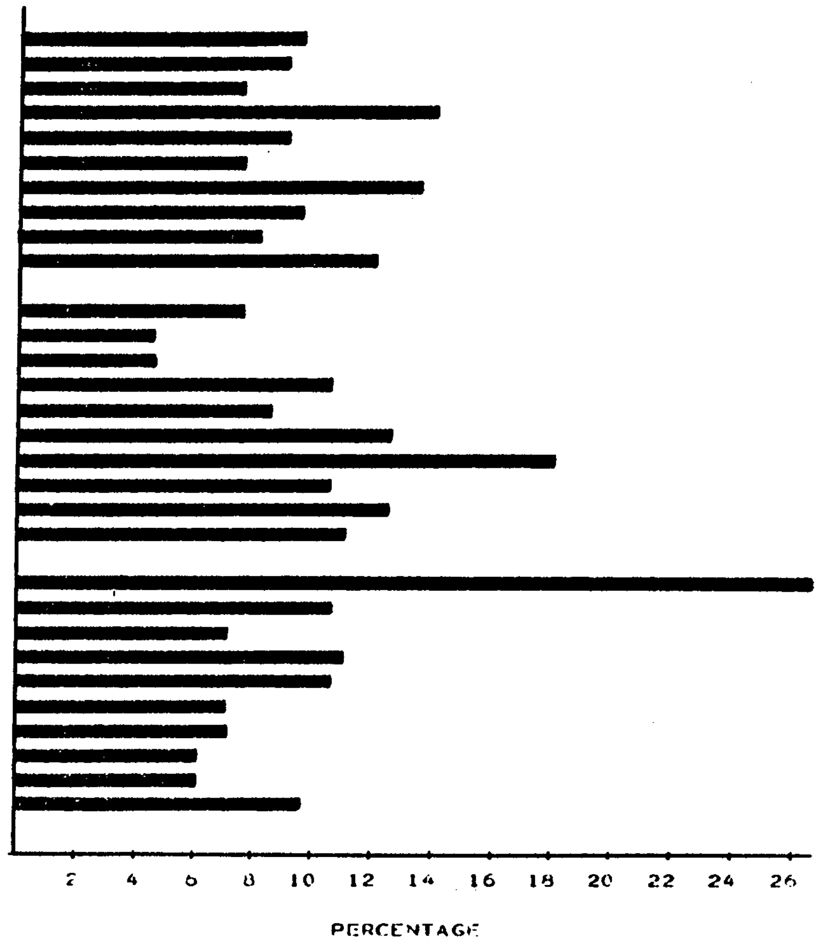
PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	0:<1	297	297	35.91	35.91
	1:1-4	201	498	24.30	60.22
	2:4-6	36	534	4.35	64.57
	3:6-10	51	585	6.17	70.74
	4:10-15	56	641	6.77	77.51
	5:15-20	48	689	5.80	83.31
	6:20-30	61	750	7.38	90.69
	7:30-40	29	779	3.51	94.20
	8:40-60	28	807	3.39	97.58
	9:>60	20	827	2.42	100.00
HOSTILE FIXED	0:<1	308	308	27.67	27.67
	1:1-4	146	454	13.12	40.79
	2:4-6	42	496	3.77	44.56
	3:6-10	89	585	8.00	52.56
	4:10-15	92	677	8.27	60.83
	5:15-20	98	775	8.81	69.63
	6:20-30	151	926	13.57	83.20
	7:30-40	80	1006	7.19	90.39
	8:40-60	61	1067	5.48	95.87
	9:>60	46	1113	4.13	100.00
HOSTILE ROTOR	0:<1	300	300	56.18	56.18
	1:1-4	106	406	19.85	76.03
	2:4-6	18	424	3.37	79.40
	3:6-10	31	455	5.81	85.21
	4:10-15	24	479	4.49	89.70
	5:15-20	13	492	2.43	92.13
	6:20-30	10	502	1.87	94.01
	7:30-40	8	510	1.50	95.51
	8:40-60	9	519	1.69	97.19
	9:>60	15	534	2.81	100.00

Figure 4. Distribution of Times from Designate to Intervisibility End for All Engagements of Correlated Targets. Summary Over All Trials.

PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	<1 SEC	13	13	9.70	9.70
	1 TO 4 SEC	12	25	8.96	18.66
	4 TO 6 SEC	10	35	7.46	26.12
	6 TO 10 SEC	19	54	14.18	40.30
	10 TO 15 SEC	12	66	8.96	49.25
	15 TO 20 SEC	10	76	7.46	56.72
	20 TO 30 SEC	18	94	13.43	70.15
	30 TO 40 SEC	13	107	9.70	79.85
	40 TO 60 SEC	11	118	8.21	88.06
	>60 SEC	16	134	11.94	100.00
HOSTILE FIXED	<1 SEC	40	40	7.55	7.55
	1 TO 4 SEC	24	64	4.53	12.08
	4 TO 6 SEC	23	87	4.34	16.42
	6 TO 10 SEC	55	142	10.38	26.79
	10 TO 15 SEC	46	188	8.68	35.47
	15 TO 20 SEC	66	254	12.45	47.92
	20 TO 30 SEC	96	350	18.11	66.04
	30 TO 40 SEC	56	406	10.57	76.60
	40 TO 60 SEC	65	471	12.26	88.87
	>60 SEC	59	530	11.13	100.00
HOSTILE ROTOR	<1 SEC	41	41	26.28	26.28
	1 TO 4 SEC	16	57	10.26	36.54
	4 TO 6 SEC	11	68	7.05	43.59
	6 TO 10 SEC	17	85	10.90	54.49
	10 TO 15 SEC	16	101	10.26	64.74
	15 TO 20 SEC	11	112	7.05	71.79
	20 TO 30 SEC	11	123	7.05	78.85
	30 TO 40 SEC	9	132	5.77	84.62
	40 TO 60 SEC	9	141	5.77	90.38
	>60 SEC	15	156	9.62	100.00

targets would have been in the process of masking at about the same time the slew was completed. The crew might never have seen the target unless the gunsight was initially pointed directly at the target.

As shown in Figures 5 and 6, the amount of time spent processing other targets was a major factor in crew reaction time. Designations were categorized as either (1) designations for reaction-type engagements or (2) designations for servicing-type engagements. The first category, reaction designations, were the designations made in response to the appearance of a target when no other target was currently designated. The second category, servicing designations, were the designations made on targets that appeared while another target already was being designated. In this situation, the crew had to terminate the previous engagement before designating the new target.

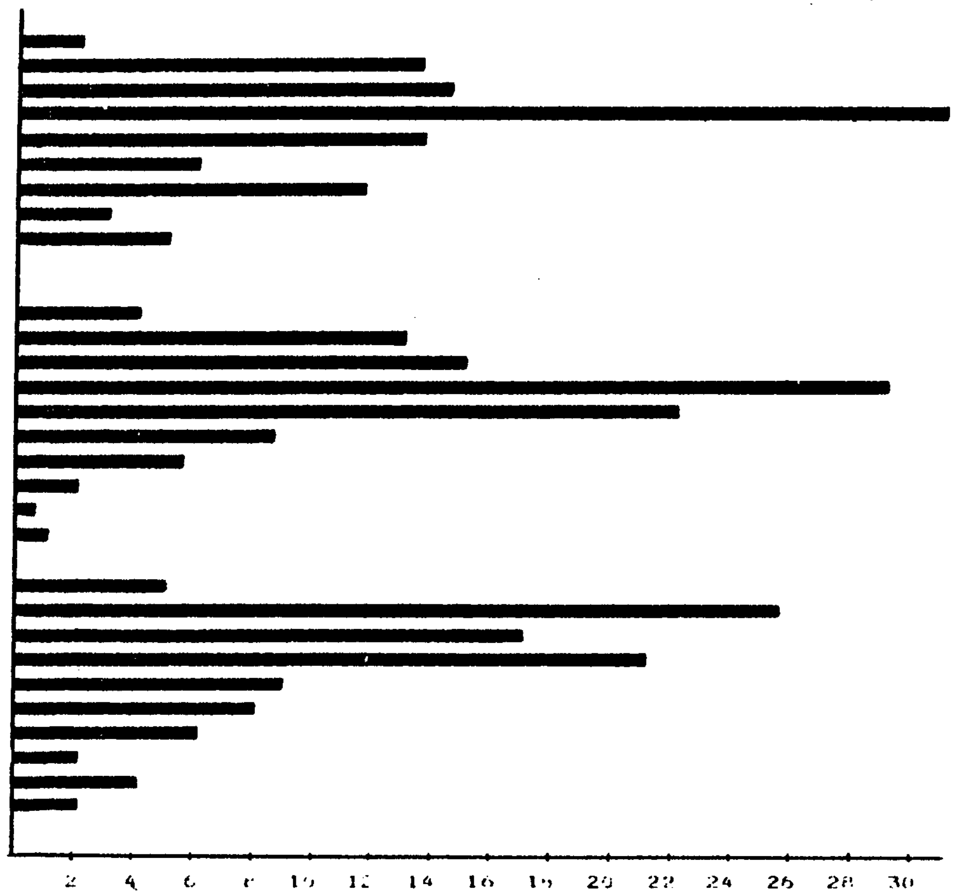
When the two types of engagements are compared (Figures 5 and 6), the crew response times to start of intervisibility are distributed more toward short duration for reaction designations than for servicing designations. Such a finding is reasonable, since the servicing designation times must include the time it took to terminate the existing designation as well as the time to make the new designation. The exception to this would be the less than 1.0 second interval for rotary-wing targets. In this case, only 5.05% of the reaction designations were made in under 1 second, but 22.81% of the servicing designations were made that quickly. Perhaps the fact that a target was being tracked raised the level of attention and when a hostile rotary-wing target was sighted that was judged to constitute a more immediate threat, the crewmember was able to, and decided to, switch immediately to the new threat. Overall, however, the mean for the servicing designation of hostile rotary-wing targets is almost 1.5 seconds longer than the mean for reaction designations. The difference in distributions was statistically significant at the .05 level for responses to fixed-wing and rotary-wing aircraft.

As shown in Figures 7 and 8, the distribution times from designate to intervisibility end indicated that many hostile rotary-wing targets masked soon after they were designated. For reaction-type engagements (Figure 7), 32% of the durations were 4.0 seconds or less. Servicing-type engagements (Figure 8) had durations of 4.0 seconds or less for 44% of the trials. This difference was not statistically significant.

The distribution of durations for hostile fixed-wing aircraft between reaction-type and servicing-type engagements was statistically significant at the .05 level. In contrast to rotary-wing aircraft, there were longer durations for reaction designations for fixed-wing aircraft. The crewmembers were able to acquire fixed-wing targets when they appeared if no other targets required their attention. Fixed-wing targets were tracked until they came into engagement range. During

Figure 5. Distribution of Times from Intervisibility Start to Designate for Reaction Type (Single Threat) Engagements. Summary Over All Trials.

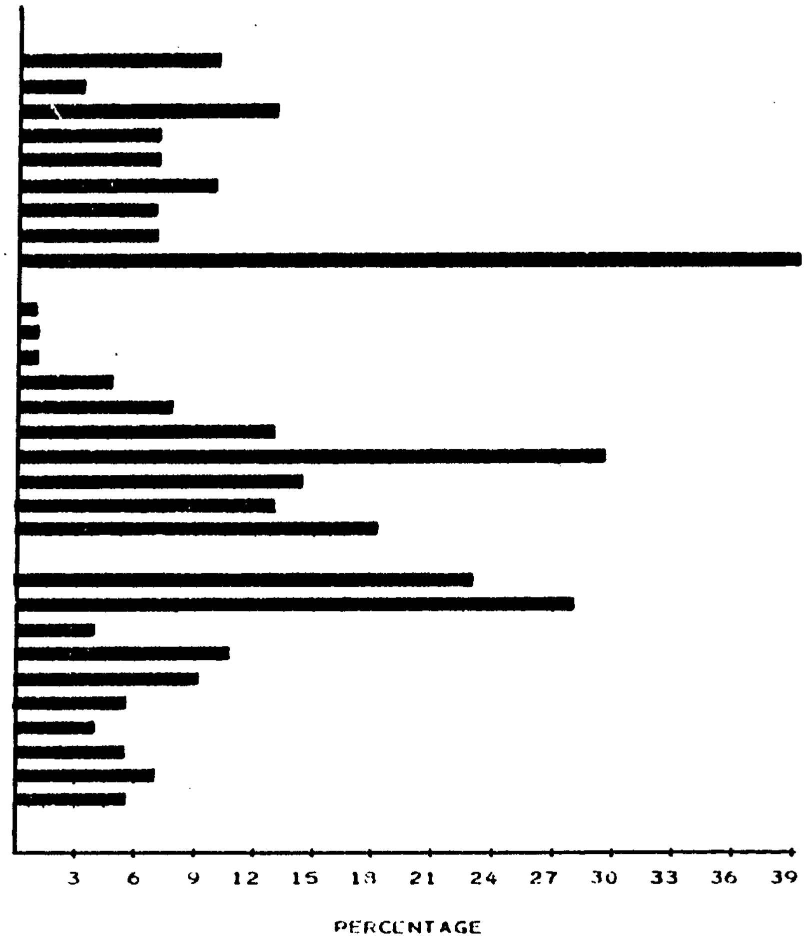
PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	0:<1	2	2	1.94	1.94
	1:1-4	14	16	13.59	15.53
	2:4-6	15	31	14.56	30.10
	3:6-10	32	63	31.07	61.17
	4:10-15	14	77	13.59	74.76
	5:15-20	6	83	5.63	80.58
	6:20-30	12	95	11.65	92.23
	7:30-40	3	98	2.91	95.15
	8:40-60	5	103	4.85	100.00
	9:>60	0	103	0.00	100.00
HOSTILE FIXED	0:<1	13	13	4.05	4.05
	1:1-4	42	55	13.08	17.13
	2:4-6	48	103	14.95	32.09
	3:6-10	93	196	28.97	61.06
	4:10-15	71	267	22.12	83.18
	5:15-20	27	294	8.41	91.59
	6:20-30	17	311	5.30	96.88
	7:30-40	6	317	1.87	98.75
	8:40-60	1	318	0.31	99.07
	9:>60	3	321	0.93	100.00
HOSTILE ROTOR	0:<1	5	5	5.05	5.05
	1:1-4	25	30	25.25	30.30
	2:4-6	17	47	17.17	47.47
	3:6-10	21	68	21.21	68.69
	4:10-15	9	77	9.09	77.78
	5:15-20	8	85	8.08	85.86
	6:20-30	6	91	6.06	91.92
	7:30-40	2	93	2.02	93.94
	8:40-50	4	97	4.04	97.98
	9:>60	2	99	2.02	100.00

Figure 6. Distribution of Times from Start Intervisibility to Designate for Servicing Type (Multiple Threat) Engagements. Summary Over All Trials.

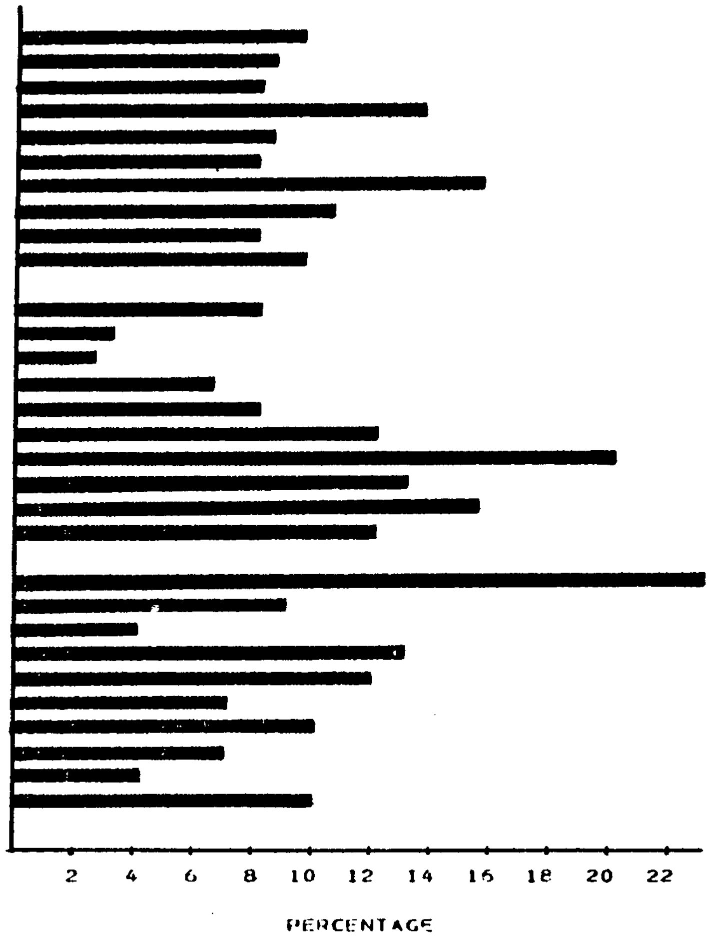
PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	<1 SEC	0	0	0.00	0.00
	1 TO 4 SEC	3	3	9.68	9.68
	4 TO 6 SEC	1	4	3.23	12.90
	6 TO 10 SEC	4	8	12.90	25.81
	10 TO 15 SEC	2	10	6.45	32.26
	15 TO 20 SEC	2	12	6.45	38.71
	20 TO 30 SEC	3	15	9.68	48.39
	30 TO 40 SEC	2	17	6.45	54.84
	40 TO 60 SEC	2	19	6.45	61.29
	>60 SEC	12	31	38.71	100.00
HOSTILE FIXED	<1 SEC	1	1	0.48	0.48
	1 TO 4 SEC	1	2	0.48	0.96
	4 TO 6 SEC	1	3	0.48	1.44
	6 TO 10 SEC	9	12	4.31	5.74
	10 TO 15 SEC	15	27	7.18	12.92
	15 TO 20 SEC	27	54	12.92	25.84
	20 TO 30 SEC	61	115	29.19	55.02
	30 TO 40 SEC	30	145	14.35	69.38
	40 TO 60 SEC	26	171	12.44	81.82
	>60 SEC	38	209	18.18	100.00
HOSTILE ROTOR	<1 SEC	13	13	22.81	22.81
	1 TO 4 SEC	16	29	28.07	50.88
	4 TO 6 SEC	2	31	3.51	54.39
	6 TO 10 SEC	6	37	10.53	64.91
	10 TO 15 SEC	5	42	8.77	73.68
	15 TO 20 SEC	3	45	5.26	78.95
	20 TO 30 SEC	2	47	3.51	82.46
	30 TO 40 SEC	3	50	5.26	87.72
	40 TO 60 SEC	4	54	7.02	94.74
	>60 SEC	3	57	5.26	100.00

Figure 7. Distribution of Times from Designate to Intervisibility End for Reaction Type (Single Threat) Engagements. Summary Over All Trials.

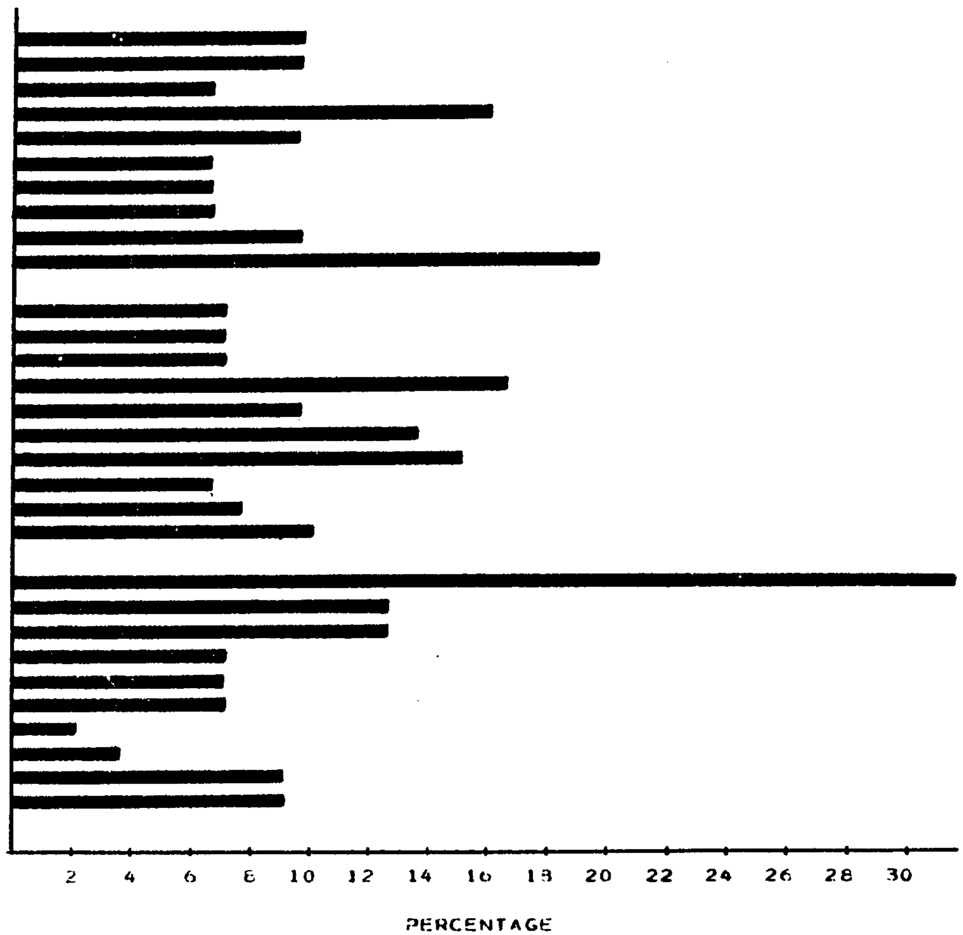
PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	<1 SEC	10	10	9.71	9.71
	1 TO 4 SEC	9	19	8.74	18.45
	4 TO 6 SEC	8	27	7.77	26.21
	6 TO 10 SEC	14	41	13.59	39.81
	10 TO 15 SEC	9	50	8.74	48.54
	15 TO 20 SEC	8	58	7.77	56.31
	20 TO 30 SEC	16	74	15.53	71.84
	30 TO 40 SEC	11	85	10.68	82.52
	40 TO 60 SEC	8	93	7.77	90.29
	>60 SEC	10	103	9.71	100.00
HOSTILE FIXED	<1 SEC	25	25	7.79	7.79
	1 TO 4 SEC	9	34	2.80	10.59
	4 TO 6 SEC	8	42	2.49	13.08
	6 TO 10 SEC	21	63	6.54	19.63
	10 TO 15 SEC	26	89	8.10	27.73
	15 TO 20 SEC	38	127	11.84	39.56
	20 TO 30 SEC	65	192	20.25	59.81
	30 TO 40 SEC	42	234	13.08	72.90
	40 TO 60 SEC	49	283	15.26	88.16
	>60 SEC	38	321	11.84	100.00
HOSTILE ROTOR	<1 SEC	23	23	23.23	23.23
	1 TO 4 SEC	9	32	9.09	32.32
	4 TO 6 SEC	4	36	4.04	36.36
	6 TO 10 SEC	13	49	13.13	49.49
	10 TO 15 SEC	12	61	12.12	61.62
	15 TO 20 SEC	7	68	7.07	68.69
	20 TO 30 SEC	10	78	10.10	78.79
	30 TO 40 SEC	7	85	7.07	85.86
	40 TO 60 SEC	4	89	4.04	89.90
	>60 SEC	10	99	10.10	100.00

Figure 8. Distribution of Times from Designate to Intervisibility End for Servicing Type (Multiple Threat) Engagements. Summary Over All Trials.

PERCENTAGE BAR CHART



TARGET	DURATION (seconds)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
FRIEND	<1 SEC	3	3	9.68	9.68
	1 TO 4 SEC	3	6	9.68	19.35
	4 TO 6 SEC	2	8	6.45	25.81
	6 TO 10 SEC	5	13	16.13	41.94
	10 TO 15 SEC	3	16	9.68	51.61
	15 TO 20 SEC	2	18	6.45	58.06
	20 TO 30 SEC	2	20	6.45	64.52
	30 TO 40 SEC	2	22	6.45	70.97
	40 TO 60 SEC	3	25	9.68	80.65
	>60 SEC	6	31	19.35	100.00
HOSTILE FIXED	<1 SEC	15	15	7.18	7.18
	1 TO 4 SEC	15	30	7.18	14.35
	4 TO 6 SEC	15	45	7.18	21.53
	6 TO 10 SEC	34	79	16.27	37.80
	10 TO 15 SEC	20	99	9.57	47.37
	15 TO 20 SEC	28	127	13.40	60.77
	20 TO 30 SEC	31	158	14.83	75.60
	30 TO 40 SEC	14	172	6.70	82.30
	40 TO 60 SEC	16	188	7.66	89.95
	>60 SEC	21	209	10.05	100.00
HOSTILE ROTOR	<1 SEC	18	18	31.58	31.58
	1 TO 4 SEC	7	25	12.28	43.86
	4 TO 6 SEC	7	32	12.28	56.14
	6 TO 10 SEC	4	36	7.02	63.16
	10 TO 15 SEC	4	40	7.02	70.18
	15 TO 20 SEC	4	44	7.02	77.19
	20 TO 30 SEC	1	45	1.75	78.95
	30 TO 40 SEC	2	47	3.51	82.46
	40 TO 60 SEC	5	52	8.77	91.23
	>60 SEC	5	57	8.77	100.00

servicing engagements, fixed-wing targets were held off on being designated until the display indicated they were in range.

As Table 19 indicates, variability existed among fire units for the percent of positive contacts receiving a friend breakoff. There was an assumed non-contact rate of 31% for correlated targets. (A correlated target is one that had been determined from information obtained either from range instrumentation or from examining thru-sight video to be a "real" target; i.e., an actual aircraft rather than a false target.)

Crews may have perceptual differences regarding the usefulness of the friend breakoff. This may be due to a lack of adequate coverage during training. Fire Unit 1 used the friend breakoff only once. Since it was on an uncorrelated target, the occurrence is not included in the table.

The Plasma Display. The crewmember responses to the information on the plasma display during Force-on-Force trials was analyzed. The results are summarized in Table 20 and Figure 9.

There were 3,784 possible targets detected by the fire unit radars and entered into the fire control computer for all fire units over the 29 valid Force-on-Force trials. Of these, 2,422 were classified by the Sgt York fire units as fixed-wing targets, and 1,362 as rotary-wing targets. Of the 3,784 possible targets detected, 2,474 were correlated threat targets at ranges of less than 6,000 meters that appeared on the plasma display. They did not necessarily remain on the display long enough to be engaged (5.0 seconds plus time of flight for the range of the target). Also, of the 3,784 possible targets, 1,692 were classified as system engagement opportunities (correlated threat targets at ranges of less than 6,000 meters that were in the search file for at least 5.0 seconds plus time of flight). Of the 1,692 system engagement opportunities, only 881 were classified as plasma (display) engagement opportunities (correlated threat targets at ranges of less than 6,000 meters that were displayed to the crew for at least 5.0 seconds plus time of flight). Thus, 811 (1692 - 881) system engagement opportunities did not meet the display engagement opportunity criterion of being displayed to the crew for at least 5.0 seconds plus time of flight. Of the 881 display engagement opportunities, the crews fired on 210 (24%). It should be noted that in the course of engaging these 210 targets, the crews designated 3,123 targets of all kinds (hostile, friend, and false).

Clearly, the Sgt York system detected many more possible targets than were displayed to the crew. Further, many of the targets that were displayed to the crew did not remain on the display long enough to be engaged. Thus, the crews had to

Table 19. PERCENT FRIEND BREAKOFFS GIVEN 31% NO-CONTACT RATE FOR CORRELATED TARGETS

TARGET	FU1	FU2	FU3	FU4	FU5	MEAN
FRIEND	0	75	61	16	72	44.8
HOSTILE FIXED	0	2	4	2	10	3.6
HOSTILE ROTOR	0	26	0	8	4	7.6

Table 20. CREW RESPONSE TO PLASMA DISPLAY

MISSION	SYSTEM DETECTS (TOTAL)	SYSTEM DETECTS (FW)	SYSTEM DETECTS (RW)	SYSTEM ENGAGMNT OPPORT.	THREAT PLASMA DISPLAYS	PLASMA ENGAGMNT OPPORT. (TOTAL)	PLASMA ENGAGMNT OPPORT. (FW)	PLASMA ENGAGMNT OPPORT. (RW)	DESIG-NATIONS	FIRINGS (TOTAL)	FIRINGS (FW)	FIRINGS (RW)	DOCTRIN. SOUND (RW)	UNEXPL. NON-FIRINGS (RW)
15	99	90	9	46	67	30	28	2	103	8	8	0	1	1
16	79	68	11	33	53	24	21	3	57	5	3	2	3	0
17	63	60	3	25	40	15	15	0	43	5	5	0	0	0
18	178	128	50	71	79	25	23	2	65	4	4	0	2	0
20	160	129	31	85	85	40	37	3	150	16	16	0	3	0
21	138	93	45	58	51	5	4	1	74	0	0	0	1	0
22	170	128	42	87	96	38	36	2	117	6	5	1	2	0
23	130	106	24	74	68	33	31	2	105	10	9	1	2	0
25	220	101	119	74	104	46	25	21	131	6	5	1	21	0
26	123	78	45	79	67	31	26	5	81	7	5	2	4	1
27	291	199	92	104	195	68	67	1	178	12	12	0	1	0
28	164	125	39	89	153	50	49	1	130	7	7	0	1	0
29	126	52	74	44	82	23	21	2	143	4	4	0	2	0
30	127	98	29	82	94	23	20	3	169	5	4	1	3	0
33	75	51	24	49	78	19	17	2	120	4	3	1	1	1
34	123	68	55	53	95	33	30	3	98	14	14	0	2	1
35	213	117	96	91	129	62	56	6	132	8	5	3	6	0
36	124	77	47	44	116	32	30	2	69	7	7	0	2	0
38	165	78	87	84	132	36	25	11	127	8	7	1	10	1
39	108	75	33	42	93	35	32	3	117	14	12	2	3	0
40	38	0	38	11	13	7	0	7	64	4	0	4	7	0
41	85	47	38	37	48	15	13	2	77	9	9	0	1	1
42	154	90	64	77	98	31	26	5	106	12	11	1	3	2
43	126	46	80	59	97	30	24	6	144	7	4	3	5	1
46	127	108	19	58	87	43	43	0	134	7	7	0	0	0
47	115	73	42	45	92	33	28	5	92	6	5	1	4	1
48	87	44	43	24	50	13	12	1	85	3	3	0	1	0
49	125	93	32	49	98	35	28	7	128	11	7	4	5	2
54	51	0	51	20	14	6	0	6	84	1	0	1	3	3
TOTAL	3784	2422	1362	1692	2474	881	767	114	3123	210	181	29	98	15

NOTES:

Mission: Force-on-force trial number

System detects (total): Radar detection of target at ranges of less than 6,000 meters, classified into fixed wing (FW) and rotary wing (RW) targets.

System engagement opportunities: Correlated (confirmed) threat targets at ranges of less than 6,000 meters that were in the search file for at least 5 seconds plus time of flight for the range of the target.

Threat plasma displays: Correlated threat targets at ranges of less than 6,000 meters that appeared on the plasma display, but did not necessarily remain on the display long enough to be engaged (5 seconds plus time of flight).

Plasma (display) engagement opportunities (total): Correlated threat targets at ranges of less than 6,000 meters that were displayed to the crew for at least 5 seconds plus time of flight, classified into fixed wing or rotary wing targets.

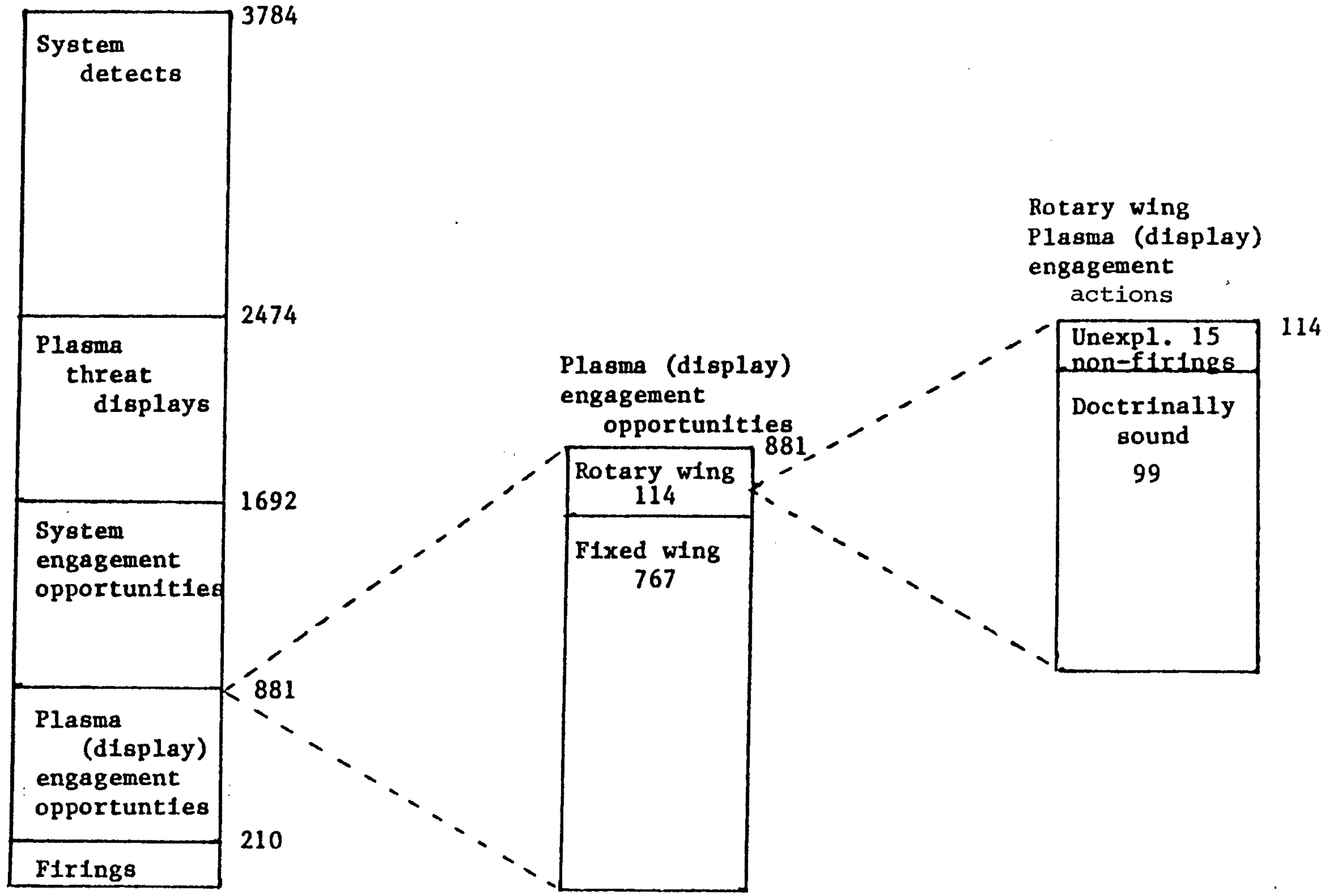
Designations: Radar pointer and laser designations.

Firings (total): Trigger pulls on designated, correlated targets that met the criteria for plasma (display) engagement opportunities, classified into fixed wing and rotary wing targets.

Doctrinally sound (RW): Rotary wing targets that were not fired at because the crews made doctrinally sound decisions not to do so.

Unexplained non-firings (RW): Rotary wing targets that were not fired at, for reasons that could not be determined by examination of plasma display and thru-sight video, and information from the 1553 data bus recordings.

Figure 9. Breakout of Crew Response to Plasma Display.



examine and eliminate many possible targets to select the relatively few targets that they engaged.

An analysis was made of the rotary-wing plasma engagement opportunities and the fixed-wing display opportunities by using the plasma display and thru-sight video. The crews fired on 181 of the 767 fixed-wing display engagement opportunities (24%), and on 29 of the 114 rotary-wing display engagement opportunities (25%). No bias toward engaging one type of aircraft rather than the other was apparent. However, it appears that approximately 75% of the target opportunities were missed.

Because of this problem, a careful examination was made of the 114 rotary-wing display engagement opportunities. This examination included determining in each case whether the helicopter was fired on, and if it was not fired upon, whether:

- o There were other threat targets at close range,
- o The crew was performing other tactically sound procedures such as pointing and engaging targets at closer ranges, or
- o The target had masked and could not be fired on.

On the basis of this examination, a decision was made for each of the 114 rotary-wing display engagement opportunities as to whether the crew performed in a doctrinally sound manner.

Of the 114 rotary-wing display engagement opportunities:

- o Twenty-nine targets were fired on.
- o Twenty-nine other targets were pointed and searched for, but had masked during turret slew or search.
- o Forty-one other targets were ignored by the crews in favor of other higher priority targets.

In these 99 cases, the crews' actions were considered to be doctrinally sound. (It should be pointed out that the crews were aware of the general locations of the 29 targets that had masked, and in combat likely would have fired in order to suppress them.) This left 15 cases, labeled "unexplained non-firings," in which for unknown reasons the crews did not fire on the targets. Examination of thru-sight and plasma video and of 1553 Data Bus printouts did not reveal reasons for the crews not firing in these cases. Figure 9 presents a graphic display of the results of this analysis.

Crew video was examined to determine whether squad leaders were operating heads-out at the times when plasma display engagement opportunities occurred (i.e., when the target appeared on the display). Squad leaders operated heads-out 38% of the total Force-on-Force trial time. However, when the display engagement opportunities occurred, squad leaders had been down in the turret for at least 5.0 seconds before the

target appeared on the display in 782 cases out of 881 (89%). This suggests that most of the squad leaders' heads-out time was during movement and lulls in the battles. As the tactical situation changed and targets began to appear, squad leaders apparently dropped down into the turret and operated from there, where they should have been to begin with.

An additional observation, indicating that the crews were using the display information properly, is that out of 107 breakoffs because the target was outbound and/or out-of-range, 72 were pointer designates; of these 72, only 10 were less than 5.0 seconds from designate to breakoff. If a target was outbound and/or out-of-range at designation, or crossed over shortly after designation, breakoff would be expected to occur almost immediately. Therefore, the indication is that crewmembers were designating targets which appeared on the display to have a high probability of being inbound and in range when engaged.

COMMUNICATIONS

Communication problems were identified during Force-on-Force and Live Fire tests from data sources consisting of questionnaires, interviews/debriefings, and crew audio-video. These problems were rated as preventing optimal mission performance. (See Table 21.)

Other communications problems identified during DT II A had not been resolved as FOE I started. These included problems associated with the exterior phone and the microphone in the "hot" mode.

There was an exterior phone for any crewmember outside the fire unit to communicate with any crewmember inside the fire unit. It would have been dangerous for the driver or anyone else to climb aboard without informing the squad leader if the vehicle had been powered up. The only means of turning on the exterior phone was from within the driver's compartment. An exterior switch for the communication phone had previously been suggested.

The microphone in each crewmember's helmet proved to be ineffective in a constant "hot" mode. It was recommended from DT II A that a foot-activated switch with a guard would eliminate a constant "hot" microphone. This would also free the hands of the gunner and squad leader. No corrective action had been taken.

Analysis of communication was conducted during FOE I. Audio transcripts were assessed for the amount of time that the squad leader spent communicating with the gunner or driver. Table 22 displays data for the amount of time the squad leader spent in communication activities.

Table 21. COMMUNICATIONS

PROBLEM: COMMUNICATIONS

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

Crews 1-5 FOF   Crews 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:
1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2.-- Degrades mission performance but normally does not prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		1	2	3	4	5	
1. Communications problems were often noted during early trials: - Interference between internal/external communications. - Increased workload on squad leader as consequence of monitoring external nets. (ref. "workload & division of labor." - Mediocre sound quality. - Interference with reception (some jamming, target slarm interference, and problems with MOPP gear).	x	x	x				x	x	x	x	x	x	x	x	x	During live fire a platoon leader at times was unable to communicate with fire units resulting in deployment delays. During Force-On-Force operations, there were some delays in movement because drivers couldn't hear. Also, to the extent that communications responsibilities bear upon squad leaders, there exists potential degradation of tactical performance.			x			Numerous comments were made about the number of different nets which squad leaders are required to monitor. Frequent mention also was made about alternative control mechanisms for reducing internal/external communications interference and interruption of tactical tasks.

Table 22. COMMUNICATIONS ACTIVITIES OF SGT YORK CREWS

Mean Percent of Trial Time Crew Communications Activity

Internal Commo	29.8
External Commo	2.8*
No Commo Activity	67.4

Internal Commo - Mean Percent Squad Leader Communicated with Gunner/Driver

		Gunner	Driver
	All Trials (N-29)	14.3	15.5
Electronic Warfare Condition	IOC Trials (N=13)	12.7	17.8
	Design Trials (N=13)	15.6	13.0
	Benign Trials (N=3)	16.0	15.0
Scenario Grouping	Attack Trials (N=14)	14.5	15.5
	Delay Trials (N=10)	12.9	18.0
	Road March Trials (N=5)	16.2	10.2

External Commo - Mean Percent of Trial Time Squad Leader Spent on External Commo (tactical commo only)

IOC Trials	2.9
Design Trials	2.7
Benign Trials	2.6

*Classification of the 2.8 percent external communications

a. with Platoon Leader

Red threat status	30.0
SY status reports	33.9
SY repositioning	8.4

b. with other SGT Yorks

Status and repositioning	27.6

During Force-on-Force trials, the squad leaders spent 15.5% of trial time talking with the driver. Virtually all of the time was spent directing the driver around nearby obstacles. This required the squad leaders to be heads-out, and their attention was directed away from the immediate air battle. It was also noted that the squad leader spent less time talking to the driver during the road march scenarios than during attack of delay-type trials. It is interesting to note that squad leaders spent less time communicating with gunners than with drivers (14.3% vs. 15.5%). In part, this was a result of the nature of the directions given to the gunners as compared to the drivers. Only 2.8% of total trial time was spent in external communication. External communication was further analyzed by percentage for platoon leader and other Sgt Yorks. (See Table 22 for classification of the 2.8 percent external communication.)

The number of external communications made to or from a Sgt York was also computed from the audio transcripts. Thirty percent (30%) of the external communications were made by the platoon leader advising a given fire unit about Red Force activity (either ground or air). This does not include the early warning net which was not analyzed due to relatively low frequency of use. About 34% (33.9%) of external communications dealt with status reports to the platoon leader. These included such information as position location or movement status. About 28% (27.6%) of the external communications were with other fire units in the platoon. Information in these reports included position location, relative repositioning of the two fire units, or Red Force activity reports. Only 8.4% of the external communications were made by the platoon leader to reposition a fire unit. A further breakdown (not shown in the table) indicates that approximately 47% was repositioning of a fire unit as a result of Red Force activity, 18% was the result of mechanical breakdown, 6% was due to a fire unit being killed, and 29% was orders given to maintain the preplanned operational order.

The relatively low percentage of total external communications (8.4%) relating to repositioning of fire units by the platoon leader was likely the result of (1) preplanned orders, (2) doctrine permitting individual fire units to maintain command and control, and (3) the fact the maneuver area for the test was small enough so that a given fire unit could likely cover the entire area for its section.

TRAVEL AND NAVIGATION

Travel and navigation of the Sgt York Air Defense Gun System was rated by all crewmembers using questionnaires and interview/briefings. Mission performance was found to be seriously degraded. There were visibility problems under all weather conditions, and in daylight as well as under night conditions. (See Table 23.)

Table 23. TRAVEL/NAVIGATION

PROBLEM: Travel/Navigation

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 POF CREWS 6-9 LF

Dash (-) indicates that this problem was not measured or not applicable for these crews

IMPACT SERIOUSNESS KEY:

1.-- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2.-- Degrades mission performance but normally does not. prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW # 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS 1	2	3	4	5	REMARKS
Drivers have a visibility problem under all weather conditions and in both daylight and darkness.	x	x					x	x	x	x	x	x	x	x	x	Movement maneuvers have been slowed and there have been near collisions.				x		There have been criticisms of the vision blocks ("blind spots"). Protective gear (laser glasses, face masks) also contribute to the problem. Additionally, the NVG problem (see " Safety" section) makes night driving difficult. Finally, when SGT YORK travel in close proximity (one behind the other) depending upon the terrain, dust generated by the lead fire unit frequently obscures the vision of drivers in trailing units.

The primary human factors problem in travel and navigation was that the drivers lacked visibility. They were not able to see where they were going unless the hatch was open. The squad leader then had to spend a substantial amount of his time heads-out (15.5%), directing the driver. All Force-on-Force drivers commented frequently and at length on this problem during post-trial debriefings and on the Force-on-Force questionnaire. The Sgt York crewmen found the terrain at Ft. Hunter-Liggett difficult and demanding in off-road maneuvering. Their earlier experience and training at Ft. Bliss had not prepared them for the Hunter-Liggett terrain. Their debriefing comments after the early Force-on-Force trials made this clear. However, even after several weeks of intense experience maneuvering the Sgt York fire units during Force-on-Force trials, the problem was still a very substantial one.

The height of Sgt York fire units, particularly with antennas erected, caused difficulties in maneuvering on the range at Ft. Hunter-Liggett. This was reported in post-trial debriefings by all of the Force-on-Force crews. On occasions, antennas hit trees and were damaged. In other cases, crews noted that they had to slow down and stow antennas to avoid hitting tree limbs. Squad leaders also commented that it was hard to hide the fire units because they were so high.

During the early Force-on-Force trials, the drivers were frequently driving through mud and water on the range at Ft. Hunter-Liggett. This driving was performed under the "heads-out" condition a substantial portion of the time. Later, the range dried up. Four of the five drivers reported that mud and water splashed up and entered the driver's compartment. On several occasions, drivers were thoroughly soaked. When the drivers closed their hatches, the mud covered their vision blocks which forced them to go heads-out. The mud and water made the operation of the controls much more difficult. This was a serious problem, especially because it made the brake pedal slippery. Adverse safety implications emerged due to the travel and navigation issues. Effective performance of crewmember duties in maneuvering the Sgt York fire unit was also degraded.

No data were collected on the performance of the Sgt York Air Defense Gun System in maintaining ground situation data (locations of task force and coverage of sectors). This was due to the short 20-30 minute trial format, as well as the narrow battlefield adopted for the Force-on-Force phase of the test.

An additional implication for the lack of data collection as to location of fire unit to task force, etc., impinged on battery status. Testing constraints did not allow for data collection associated with battery status for number of rounds left, Defense Condition (DEFCON), and alert status.

PUBLICATION/DOCUMENTATION

Observations by human factors evaluators and data from questionnaires revealed that operator and maintenance manuals were difficult to use. This was assessed as having a minor effect on mission performance. (See Table 24.)

A specific example of this type of problem occurred during DT II B. The operator's manual did not provide a warning regarding the fire buttons on the M239 grenade launcher. This was later corrected in the operator's manual for the firing sequence of the grenade launcher with appropriate warnings. However, FOE I findings indicated that a problem remained with the M239 firing button label. The label was misleading, and should have been revised to read Salvo 1 and Salvo 2 instead of right and left. Either fire smoke button fired three grenades simultaneously from both sides.

SAFETY

Safety problems reported during FOE I were categorized into ten problem areas. Each safety problem was identified according to data source, crew number, probability of hazard, and the severity of the safety hazard.

Restraints were identified as a safety hazard through questionnaires, interviews/debriefings, crew audio-video, and observations by human factors evaluators. Shoulder restraints and seat belts were rated with a Category II which is indicative of potentially severe personal injury. This level of hazard was frequent and continuously experienced.

Crew restraints were frequently described as inadequate. The inertia reels on the shoulder restraints for the gunner and squad leader did not catch quickly enough when the vehicle stopped suddenly. The restraints did not prevent the crewmen from being thrown forward and striking the gunsight, periscope, or whatever else was in proximity to the crewmembers' heads. This problem was reported during DT II A, and had not been resolved prior to FOE I. (See Table 25.)

A safety problem arose during Force-on-Force trials when drivers were struck in the head by the turret when it rotated. This was documented by questionnaires, interviews/debriefings, and observations. The probability of occurrence was rated as frequent, and the safety hazard severity was rated for severe injury. To alleviate the problem, drivers had to drive with the hatch closed. This approach to driving contributed to and enhanced the problem of visibility from the driver's compartment. Force-on-Force and Live Fire crews reported inadequate visibility from the driver's compartment. Visibility problems were experienced under day, night, and inclement weather conditions. There was limited vision of objects and terrain close to the vehicle. Too many blind spots existed between the three

Table 24. PUBLICATION/DOCUMENTATION

PROBLEM: Publication/Documentation

DATA SOURCE KEY:
- Q -- Questionnaires
- I -- Inverview/Debriefings
- V -- Crew Audio-Video
- TSV - Through Sight Video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

CREWS 1-5 POF   CREWS 6-9 LF

IMPACT SERIOUSNESS KEY:
1 -- Minor effect on mission performance. Makes mission performance more difficult only occasionally.
2 -- Degrades mission performance but normally does not prohibit effective engagement.
3 -- Prevents optimal mission performance. Effects can be minimized by additional training.
4 -- Seriously degrades mission performance. Frequently or always degrades effective target engagement.
5 -- Very serious. Can prevent mission performance.

PROBLEM	DATA SOURCE						CREW #									HOW SYSTEM PERFORMANCE AFFECTED	IMPACT SERIOUSNESS						REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	
Operators and maintenance manuals are cumbersome and difficult to use.	x				x											The danger lies in the fact that if crewmembers need to consult a manual for quick reference to important procedures, an unwieldy manual will produce confusion and lowered efficiency.		x					Several comments were made to the effect that the manuals: - are toothick and difficult to store. - are not well indexed. - include unneeded material. - lack necessary material. - should be specific to each of the different crew positions.

Table 25. SAFETY

PROBLEM AREA: Safety

Data Source Key:
- Q -- Questionnaires
- I -- Interview/Debriefings
- V -- Crew Audio-Video
- TSV - Thru-sight video
- O -- Observation by Human Factors Evaluators
- B/P - 1553 Data Bus or Plasma Display

Safety Hazard Severity: *
- I. Catastrophic - death or system loss.
- II. Severe injury, severe occupational illness or major system damage
- III. Minor injury, minor occupational illness or minor system damage.
- IV. Less than minor injury, occupational illness, or system damage.

Hazard Probability: *
- A. Frequent - Continously experienced
- B. Probably - Will occur frequently
- C. Occasional - Will occur several times
- D. Remote - Unlikely but can reasonably be expected to occur
- E. Improbable - Unlikely to occur, but possible

CREW #
- 1-5 -- Force-On-Force
- 6-9 -- Live Fire

* IAW MIL-STD 882B - Military Standard System Safety Program

PROBLEM	DATA SOURCE						CREW NUMBER									HOW SYSTEM PERFORMANCE AFFECTED	HAZARD SEVERITY				HAZARD PROBABILITY					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		I	II	III	IV	A	B	C	D	E	
1. Restraints	X	X	X		X		X	X	X	X	X		X			During FOE I, the rough terrain resulted in many sudden stops, and crews reported that they were thrown forward. This was a special problem for gunners, who were thrown into the inadequately padded gunsight.		X				X				This problem was previously reported in DT II A, but it has not been corrected.
a. Shoulder restraints in the crew compartment do not fully prevent forward movement, due to slow catch spring.																										
b. Seat belts don't hold personnel in their seats.																										

Table 25. SAFETY (Cont.)

PROBLEM AREA: Safety

Data Source Key:
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CREW #
- 1-5 -- Force-On-Force
- 6-9 -- Live Fire

* IAW MIL-STD 882B - Military Standard System Safety Program

PROBLEM	DATA SOURCE Q	I	V	TSV	O	B/P	CREW NUMBER 1	2	3	4	5	6	7	8	9	HOW SYSTEM PERFORMANCE AFFECTED	HAZARD SEVERITY I	II	III	IV	HAZARD PROBABILITY A	B	C	D	E	REMARKS
2. Drivers are struck in the head by the turret when it rotates.	x	x			x		x	x	x	x	x					During the early FOE I trials, the rotating turret would strike the back of the CVC helmets. Thus the drivers had to drive with the hatch closed, contributing to the next problem area (#3).		X				X				Not only may visibility and ability to maneuver be degraded by this situation, but it also may force the squad leader to engage in more heads-out support of the driver.
3. Inadequate visibility from driver's compartment under all conditions (night, day & inclement weather).	x	x	x		x		x	x	x	x	x		x	x	x	Prior to FOE I maneuvers, the drivers were not trained for the wooded and muddy terrain. They have limited vision of objects and terrain close to the vehicle. This is especially true regarding visibility of objects above the drivers line of sight. As a consequence during FOE I the squad leaders spent a great deal of time directing the drivers.		X				X				Due to the three separate vision blocks, too many blind spots exist. The gunsight and periscope are especially poor for night vision. Contributary factors reported are: -- poorly angled night driving scope. -- limiting effect of combined laser glasses and face mask during MOPP operations. -- The effect of smoke from long gun bursts upon visibility.

Table 25. SAFETY (Cont.)

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CREW #
- 1-5 -- Force-On-Force
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PROBLEM	DATA SOURCE						CREW NUMBER									HOW SYSTEM PERFORMANCE AFFECTED	HAZARD SEVERITY				HAZARD PROBABILITY					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		I	II	III	IV	A	B	C	D	E	
4. Night vision, visibility and goggles	x	x			x		x	x	x	x	x					During the two night trials, the drivers could not see to drive. The infrared (IR) lights were not used due to vulnerability from the AH-64 helicopter. Since the NVG's don't work without IR lights, they were ineffective, and one SGT YORK crew drove into a ditch.		x			x					Due to the hazards encountered during the first night trial, the second trial was conducted at dusk.
5. No fire extinguisher in the gun bay.	x	x			x						x					Prior to the start of trial 1033, there was a fire in the gun bay, and the crew had to manually open the key way and fire wall in order to use a fire extinguisher. There was another fire in FU 5 on 24 June 85 during test at McGreggor Range.	x							x		There should be automatic fire extinguishers in the gun bay similar to that in the PPU. This is important due to the possibility of live ammunition detonating.

Table 25. SAFETY (Cont.)

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CREW #

1-5 -- Force-On-Force
6-9 -- Live Fire

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PROBLEM	DATA SOURCE						CREW NUMBER									HOW SYSTEM PERFORMANCE AFFECTED	HAZARD SEVERITY				HAZARD PROBABILITY					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		I	II	III	IV	A	B	C	D	E	
6. Inadequate and unsafe workspace in the driver's compartment.	x	x			x		x	x	x	x	x	x	x	x	x	The second most frequent comment from the drivers (next to the visibility issue) pertains to the cramped workspace and resultant problems in operating the brake and gas pedals.		x			x					In almost every trial, drivers report sore backs and slow reaction times in brake operation. The combination of inadequate leg room, insufficient head room, and lack of adequate air circulation constitutes an unsafe driver workspace One driver even commented that he had to manually assist in lifting his leg in order to reach the brake pedal. A factor which may compound the problem is that of seats which some crewmembers describe as difficult to adjust.
7. Location of Hydraulic lines	x								x							One crewmen commented that a hydraulic line is located right behind the squad leader's head and that the hole in front of the line leaves his head unprotected should it rupture.		x							x	An investigation into this matter showed that the hydraulic line runs along the inside wall of the turret, above and to the right of the SL. There is a coupling where the line makes a 90 degree turn as it enters the turret interior, which is covered by a protective shroud. The line is sufficiently protected in the probability of a rupture is very low.

Table 25. SAFETY (Cont.)

PROBLEM AREA: Safety

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PROBLEM	DATA SOURCE						CREW NUMBER									HOW SYSTEM PERFORMANCE AFFECTED	HAZARD SEVERITY				HAZARD PROBABILITY					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		I	II	III	IV	A	B	C	D	E	
8. NBC (MOPP gear) is very hot, and it also creates visual problems.	x	x					x	x	x			x	x	x	x	Extreme heat over time will degrade operator performance markedly. Visual problems involving the simultaneous use of laser goggles and face mask can interfere both with navigation and target detection.			x				x			A number of comments were made about the CBR fan, which apparently fails ocassionally. Also, one comment about the CBR is that it cools the face only.
9. Sharp edges and slippery surfaces pose a danger to crewmen.	x	x			x		x	x	x	x	x	x	x	x	x	Injury and/or the threat of injury can degrade crew performance over time. Loss of personnel, even if temporary, should be of great concern given the high skill requirement of the SGT YORK.			x				x			Crewmen have commented on a number of specific problems. The outside surface of the hull is slippery and lacks sufficient handholds. Also, hydraulic fluid, mud and water can make the crew areas treacherous. In addition, rough, sharp edges on the squad leaders hatch has been frequently mentioned as a hazard.

Table 25. SAFETY (Cont.)

PROBLEM AREA: Safety

Data Source Key:
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CREW #
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PROBLEM	DATA SOURCE						CREW NUMBER									HOW SYSTEM PERFORMANCE AFFECTED	HAZARD SEVERITY				HAZARD PROBABILITY					REMARKS
	Q	I	V	TSV	O	B/P	1	2	3	4	5	6	7	8	9		I	II	III	IV	A	B	C	D	E	
10. The driver has the capability of setting the Fire Unit in motion at a constant rate of speed using the accelerator lock. Also, if the driver is disabled with his foot on the accelerator, there is no way to stop the vehicle.		x			x											In a worst case scenario, if the accelerator lock is applied while the vehicle is moving and the driver falls unconscious, neither the squad leader nor the gunner would be able to stop the vehicle quickly. The vehicle would be out of control with catastrophic consequences.	X								x	1. The accelerator lock is used to keep the engine idling within a certain RPM range over long periods, for example, while being used as the auxiliary power source for the system. 2. Although drivers are trained to use the accelerator lock only while stationary, the possibility of applying it during movements exists. 3. It is suggested that the feasability of the main engine "kill" switch in the turret be considered.

separate vision blocks. This problem was rated as potentially causing severe injury, and/or major system damage. (See Table 25.)

A related visibility problem dealt with the issue of night vision. During Force-on-Force on the two night trials, drivers could not see to drive. This problem was identified through source material from questionnaires, interviews/debriefings, and observations by human factors evaluators. Night visibility goggles were ineffective without the use of infrared lights. (See Table 23.) One Sgt York crew drove into a ditch. (See Table 25.)

Another safety problem identified was that there was no fire extinguisher in the gun bay. This problem was identified by one Force-on-Force crew that had a fire in the gun bay. A rating of catastrophic-death or system loss was selected with a recommendation to provide automatic fire extinguishers in the gun bays similar to that in the PPUs.

There were CO2 fire extinguishers in the crew compartments. During DT II B, a portable halon extinguisher was recommended for the gun bay and ammo storage areas. This problem had not been corrected prior to FOE I. (See Table 25.)

It was reported by all crews on Force-on-Force and Live Fire that the drivers workspace was inadequate and unsafe. This was documented by questionnaires, interviews/debriefings, and observations by human factors evaluators. The cramped workspace resulted in problems with operating the brake and gas pedals. These frequently experienced problems such as slow reaction time in brake operation could result in severe injury or major system damage. (See Table 25.)

One Force-on-Force crew identified the location of the hydraulic lines as a problem. The hydraulic line was located behind the squad leader's head. The hole in front of the line would have left the squad leader's head unprotected in case of rupture. This problem was rated as improbable-unlikely to occur, but possible. However, in such an occurrence, it had the potential to cause severe injury or major system damage. During DT II B, frequent hydraulic leaks in the system caused a fire and fume hazard. However, new precision hydraulic fittings were to be incorporated into production units. (See Table 25.)

NBC gear was identified as a safety problem since it induced extreme heat conditions over time and created visual problems for the operators. These conditions were rated by Force-on-Force and Live Fire crews at the level of minor injury or minor system damage. Laser goggles and face masks used simultaneously were found to interfere with both navigation and target detection. (See Table 25.)

Sharp edges and slippery surfaces were determined to be a safety problem. Force-on-Force and Live Fire crewmembers identified this problem through questionnaires, interviews/debriefings, and observations by human factors evaluators. Rough, sharp edges on the squad leader's hatch were considered a hazard. The surface of the hull was slippery and lacked sufficient handholds. Hydraulic fluid, mud, and water made the crew areas slippery. This was rated as occasional-will occur several times, and safety hazard severity level as minor injury. (See Table 25.) This problem was identified during DT II B: bolts around the inside of the hull over the driver's controls were longer than necessary and had sharp edges.

Drivers were trained to use the accelerator lock only while the fire unit was stationary. There was the possibility of applying the accelerator lock during movements so that the fire unit could have been set in motion at a constant rate of speed. The accelerator lock was considered a safety problem, although the hazard probability was rated as improbable/unlikely to occur, but possible. If the driver had become disabled while the fire unit was in operation, the squad leader and gunner would not have been able to stop the vehicle quickly. The safety hazard severity for this condition was rated as catastrophic-death or system loss. There were no means for the squad leader or gunner to power down the main vehicle engine from the turret. (See Table 25.)

A further breakdown of the data regarding the human factors physical and environmental aspects of the crew compartment and safety issues which were associated with the Sgt York Air Defense Gun System are found in Appendix A. These data consist of the crewmembers' debrief comments. The comments are listed in order of decreasing frequency. Topic areas include, but are not limited to, the following: Visibility, Workspace, Anthropometrics, Communication, Comfort, Workload, Target Acquisition, Safety, and Controls and Displays.

TRAINING

Individual and collective training results will be presented. These results were obtained from multiple sources:

- o Examination scores from crewmen attending Sgt York classes,
- o Center certification report prepared at the completion of collective training,
- o Post-mission debriefs and questionnaires completed during FOE I,
- o Observations of crew activities recorded on video tapes and an analysis of the onboard 1553 data bus recordings,

- o Observations by RAM and HFE data collectors during maintenance recorded on Incident Data Sheets in the RAM Data Base, and

- o The Operational Test Readiness Statements (OTRS) provided by the Training and Doctrine Command (TRADOC).

Individual Training. MOS 16L20/30/40-T training was conducted at Ft. Bliss from 15 October to 21 December 1984. The training was conducted by the 1st Inst Bn (Prov), 1st ADA Trng Bde. Modification of the Program of Instruction (POI) reduced instructional time from 11 weeks, 2 days to 6 weeks, 3 days. This was due to limited training days available before the initiation of FOE I. See Table 26 for a comparison of FOE Program of Instruction (POI) hours and the proposed future Program of Instruction (POI).

The 16L crewmen received a hands-on and a written exam at the conclusion of their individual training course. A passing score for the course required a score of 90% or above. There were 36 trainees who enrolled in the course. Of the 36, 29 graduated, and the other 7 were not awarded diplomas. After a review of the test scores by the battery command, the 7 trainees who did not achieve a score of 90% had their test scores reassessed. It was decided to retain 5 of the 7 individuals, and return 2 individuals to their unit. The 5 soldiers retained by the unit consisted of 2 gunners (1 primary and 1 alternate), and 3 drivers (2 primary and 1 alternate). Six of the 16L crewmen had previous Sgt York experience. They were trained by FACC, and did not attend the 16L course. See Table 27 for a breakdown on individual and collective training scores.

A more extensive breakdown of tasks is displayed for the resident training taught in the 16L Transition course. This information is located in Appendix B.

Maintainer (MOS 224D and 24W/20/30/40) individual training was conducted at Fort Bliss between 5 November 1984 and 14 February 1985. The Sgt York Instructor/Development Branch, SHORAD Department was responsible for the training. Modification of the Program of Instruction resulted in course reduction time from the proposed 28-week course to 12 weeks, 3 days. This reduction was due to the accelerated test schedule. See Table 28 for a further delineation of how the training hours were reduced.

Maintenance personnel were tested throughout the course of instruction. Maintenance trainees did not complete the course, since they were sent to the field for "hands-on" training during the collective phase of training. A list of all maintenance tasks, along with lesson numbers, is found in Appendix C. Each task title and lesson number is ranked according to "qualified," "familiarized," or "not covered." In total, there

Table 26. TRAINING HOURS CONDUCTED FOR FOE 16L CREWMEN VERSUS PROPOSED POI FOR FUTURE CLASSES

	TITLE OF POI ANNEX	FOE POI	PROPOSED FUTURE POI*
A.	Introduction/Aircraft and Threat Vehicle Recognition	14	66
B.	Orientation and Fundamental Skill Building	26	27
C.	Operate and Maintain the M247	30	56
D.	Operator Corrective Actions	19	25
E.	Preparation for Action	11	19
F.	40mm Gun Operations and Maintenance	26	34
G.	Feed System Operation	13	22
H.	Engagement Sequence	16	59
I.	Degraded and Unusual Operations	13	14
J.	Auxiliary Duties	3	11
K.	Range Fire	8	32
L.	Final Examination	24	19
	TOTALS	203	386

*Program of Instruction (RCS ATTG-29RI), Course No. 043-16L20/30/40-T.

Table 27. SGT YORK FOE I GUN CREWS 16L MOS

CREW NUMBER	RANK		HEIGHT (INCHES)	WEIGHT (POUNDS)	ASVAB OF	ASVAB EL	AFQT	AND CAT	GT	TRAINING SCORES IND TNG	TRAINING SCORES COLL TNG	PREVIOUS SGT YORK EXPERIENCE
1.	SL	E-7	69	130	118	106	23	IV	108	NA	SAT	Y
	GU	E-5	73	210	105	93	19	IV	87	97.6	SAT	N
	DR	E-2	66	151	98	86	30	IV	85	89.0	Note 1	N
2.	SL	E-6	69	169	114	76	25	IV	84	91.3	SAT	N
	GU	E-5	69	130	95	109	59	IIIA	96	Fail	SAT	N
	DR	E-4	70	145	101	91	56	IIIA	99	Fail	Note 1	N
3.	SL	E-6	72	195	112	113	65	II	118	NA	SAT	Y
	GU	E-6	67	167	128	125	82	II	115	94.6	SAT	N
	DR	E-2	73	184	97	87	26	IV	80	91.1	Note 1	N
4.	SL	E-6	70	150	--	--	65	II	109	NA	SAT	Y
	GU	E-6	74	215	119	120	65	II	110	97.2	SAT	N
	DR	E-2	70	165	107	115	65	II	109	91.6	Note 1	N
5.	SL	E-6	73	196	102	109	--	IIIA	99	96.7	SAT	N
	GU	E-5	69	161	98	103	35	IIIB	80	94.9	SAT	N
	DR	E-2	69	170	108	102	59	IIIA	106	92.1	Note 1	N
6.	SL	E-7	70	160	116	125	68	II	125	96.3	SAT	N
	GU	E-5	71	155	112	97	63	IIIB	104	97.0	SAT	N
	DR	E-2	68	170	104	96	50	IIIA	96	93.8	Note 1	N
7.	SL	E-7	69	160	--	90	70	II	120	NA	SAT	Y
	GU	E-6	72	200	105	90	56	IIIA	103	Fail	SAT	N
	DR	E-2	70	164	100	105	58	IIIA	103	97.2	Note 1	N
8.	SL	E-6	66	135	--	--	80	II	120	NA	SAT	Y
	GU	E-6	70	190	93	92	27	IV	94	93.0	SAT	N
	DR	E-2	70	145	100	98	78	II	--	Fail	Note 1	N
9.	SL	E-6	70	210	--	93	17	IV	106	96.8	SAT	N
	GU	E-5	68	160	98	87	29	IV	96	NA	SAT	Y
	DR	E-2	66	142	100	98	44	IIIB	97	91.2	Note 1	N
10. *	SL	E-6	66	140	124	113	75	II	110	92.2	UNSAT	N
	GU	E-6	67	150	84	70	19	IV	89	88.6	Note 1	N
	DR	E-2	70	169	99	107	50	IIIA	100	Fail	Note 1	N

NOTE 1: Did not participate in Center Certification.
*Backup squad for Live Fire
OF - Operator/Foodhandler
EL - Electronics
ASVAB - Armed Services Vocational Aptitude Battery

AFQT - Armed Forces Qualifications Test Scores & Category
GT - General Test

Table 28. TRAINING HOURS CONDUCTED FOR MAINTENANCE (224D & 24W) FOE PERSONNEL VERSUS PROPOSED POI FOR FUTURE CLASSES

	TITLE OF POI ANNEX*	FOE POI	PROPOSED FUTURE POI (24W)
A.	Orientation	4	4
B.	Solid State Electronics	0	105
C.	Digital Fund. & Computer Circuits	0	113
D.	Operation of the SGT York	46	80
E.	SGT York Organizational Maintenance	0	14
F.	Peculiar Support Equipment (PSE)	3	9
G.	System Hardware	19	18
H.	Power Distribution	38	74
I.	Hydraulics Subsystem	65	108
J.	Gun Subsystem	56	66
K.	Feed Subsystem	60	82
L.	Environmental Control Subsystem	15	40
M.	Radar Subsystem	52	93
N.	Optics/Laser Subsystem & Safety	40	62
O.	Fire Control Subsystem	36	62
P.	Review	28	72
Q.	Maintenance Management	0	23
R.	Final Examination	12	0
	TOTALS	474	1015

*Program of Instruction (RCS ATTG-29RI), Course No. 121-24W20/30/40-T.

were 760 task lesson numbers. Of the 760, the trainees qualified in 213 task lesson numbers, they were familiarized with 486 task lesson numbers, and 61 task lesson numbers were not covered. Those task shortfalls that were not covered or were trained to familiarization only were the result of Peculiar Support Equipment (PSE) not being available, and/or insufficient time for training.

Collective Training. Collective training for the E-4/1 Btry was conducted from 31 December 1984 to 15 February 1985, approximately 7 weeks. The certification for the battery was held between 18-23 February 1985. Nine of the 10 crews were certified. The crew that was not certified consisted of two E-6s who failed one of the three scenarios presented twice on the Sgt York Conduct of Fire Trainer (SYCOFT). Five crews participated in Force-on-Force, and the other four crews remained at Fort Bliss, where they participated in additional firing training and were certified for Live Fire during the certification on 11 and 12 April 1985.

At the conclusion of collective training, a questionnaire was administered to E-4/1 personnel in order to document their comments on the adequacy of both individual and collective training. The results of the questionnaire are presented in Table 29. The data in this table represent the total responses by all of the crewmen (N=40). A further breakdown by position was conducted (not reflected in Table 29). While most of the responses reflect a favorable rating toward training (+2, +1), there are some noticeable differences within specific crew positions. For example, only 6 of 13 drivers reported a favorable (+2, +1) rating towards their individual training, but 9 of 13 rated their collective training as favorable.

At the conclusion of Force-on-Force, all five Force-on-Force drivers rated their drivers' training as inadequate based upon their experiences at Fort Hunter-Liggett. When asked, "Do you feel you received sufficient training to accomplish the air defense mission?", 20 of 40 crewmen and key personnel responded "yes." However, eight of the drivers responded "no" and commented that they had not had enough driving time. The responses by the maintenance personnel shown in Table 29 reflect a less positive evaluation of their training; 1 of 10 maintenance personnel rated their training as favorable.

Table 29. RESULTS OF INDIVIDUAL AND COLLECTIVE TRAINING QUESTIONNAIRE

QUESTION	$\bar{X}$	RATING SCALE +2	+1	0	-1	-2	NR
SGT YORK CREWMEN & KEY PERSONNEL (N = 40)							
1. How would you rate the overall individual training you received?	0.54	2	18	15	2	0	3
2. Please rate the following aspects of individual training:							
Four Unit Operation	0.66	4	21	12	1	1	1
IFF	-0.33	1	8	15	7	8	1
Early Warning	0.05	4	14	7	6	7	2
Crew Drills	-0.35	1	7	12	12	5	3
Ammo & Ammo Handling	0.69	8	18	7	5	1	1
PMCS of Chassis	1.03	11	20	6	2	0	1
PMCS of System	0.92	8	20	7	2	0	3
Engaging Targets:							
ECM Environment	-0.18	3	12	10	5	10	0
NBC Environment	-0.08	3	10	12	7	6	2
Land Navigation/Map Reading	-0.38	3	7	10	7	10	3
Smoke Operations	-0.05	6	9	7	7	8	3
3. Please rate the training you received on the following:							
Classroom Trainer (CRT)	-0.08	5	9	6	12	5	2
Fire Control Trainer (FCT)	1.00	15	15	4	4	1	0
System Maintenance Trainer (SMT)	0.90	12	17	6	2	2	0
Gun Maintenance Trainer (GMT)	1.21	13	21	5	0	0	0
Feed System Maintenance Trainer (FSMT)	0.92	10	19	6	2	1	1
SGT YORK Gun	0.92	9	18	10	1	0	1
4. How would you rate the operator's manual used during individual training (TM 9-2350-309-10) in the following areas:							
Organization	-0.45	5	16	11	3	3	0
Readability	-0.81	7	20	6	1	2	2
Completeness	0.31	5	13	10	4	4	2
Usefulness	0.62	6	13	13	0	2	4
NA = 2							
5. How would you rate the employment manual used during individual training (FM-44-11) in the following areas:							
Organization	0.03	2	9	15	4	4	0
Readability	0.02	2	13	13	1	4	1
Completeness	-0.06	1	8	16	4	4	1
Usefulness	-0.09	3	5	15	4	5	2
NA = 6							
6. How would you rate the familiarization firing conducted at the end of the individual training?	-0.84	2	3	10	4	18	2
How would you rate the 16L course manuals?	-0.23	3	16	6	6	4	5
7. How would you rate the collective training overall?	1.03	10	21	5	2	0	2
8. Please rate the following aspects of collective training in terms of coverage:							
Training in MOPP	0.58	7	17	10	4	2	0
Night Operations	1.00	16	14	6	2	2	0
Tactics	0.92	16	11	7	3	2	1
Day Maneuvering	1.28	20	13	5	2	0	0
Night Maneuvering	0.97	15	14	6	2	2	1
Practice Firing	0.82	12	13	7	6	0	2
Convoy Training	1.25	19	16	1	4	0	0
Tracking Exercises	1.49	24	11	3	1	0	1

NOTES:

* The rating categories +2, +1, 0, -1, -2 were matched with five categories Very Good, Good, Borderline, Poor, Very Poor or Very Adequate, Adequate, Borderline, Inadequate, Very Inadequate, or Very Easy, Easy, Borderline, Difficult, Very Difficult.

Table 29. RESULTS OF INDIVIDUAL AND COLLECTIVE TRAINING QUESTIONNAIRE (Cont.)

QUESTION	$\bar{X}$	RATING SCALE +2	+1	0	-1	-2	NR
SYSTEMS MAINTENANCE PERSONNEL: (224D & 24W) N - 10.							
1. How would you rate the overall individual training you received?	-0.50	0	1	2	5	0	2
2. Please rate the following aspects of individual training in terms of coverage:							
Power and Actuation (Hydraulics)	0.66	1	5	2	1	0	1
Radar Subsystem	-0.11	0	3	2	4	0	1
Fire Control Subsystem	-0.33	0	3	1	4	1	1
Gun Sybsystem	0.77	2	4	2	1	0	1
Feed Subsystem	-0.09	2	2	3	1	3	1
Optics/Laser Subsystem	0.33	1	2	5	1	0	1
Safety	1.22	3	5	1	0	0	1
Power Distribution	0.44	1	4	2	2	0	1
Environmental Control System	0.55	1	4	3	1	0	1
3. Please rate the training you received on the following:							
Gun Maintenance Trainer (GMT)	1.37	3	5	0	0	0	2
Feed System Maintenance Trainer (FSMT)	1.00	1	7	0	0	0	2
Organizational Maintenance Trainer (OMT)	-0.37	0	3	1	2	2	2
System Maintenance Trainer (SMT)	0.37	0	5	1	2	0	2
4. How would you rate the maintenance manuals used during individual training in the following areas:							
Organization	-0.10	0	3	4	2	1	0
Readability	0.50	0	6	3	1	0	0
Completeness	-1.20	0	1	1	3	5	0
Usefulness	0.0	0	3	4	3	0	0
5. How adequate was the hands-on training you received with the SGT York during individual training?	0.0	1	1	4	3	0	1
6. How adequate were the following system modes in maintenance instruction during individual training?							
Fault Isolate Mode	0.44	0	4	5	0	0	1
Maintenance Mode	0.22	0	2	7	0	0	1
7. How would you rate collective training overall?	0.60	0	8	0	2	0	0
8. How adequate were the following system modes in actual maintenance?							
Fault Isolate Mode	0.56	0	6	2	1	0	1
Maintenance Mode	0.56	0	6	2	1	0	1

NOTES:
* The rating categories +2, +1, 0, -1, 02 were matched with five categories Very Good, Good, Borderline, Poor, Very Poor or Very Adequate, Adequate, Borderline, Inadequate, Very Inadequate, or Very Easy, Easy, Borderline, Difficult, Very Difficult.

V. DISCUSSION AND CONCLUSIONS

Human factors, safety, and training problems identified during FOE I which were associated with the Sgt York Air Defense Gun System are discussed in this section. The discussion and related conclusions follow the same sequence as previously stated in the Results section. The discussion and conclusions are reported out in categories which are identified as follows: (1) Physical Environment and Workspace; (2) Workspace, Anthropometrics, Comfort; (3) Controls and Displays; (4) Workload/ Division of Labor; (5) Visibility; (6) Audio and Visual Alarms; (7) Target Detect/Acquisition/Tracking; (8) Communications; (9) Travel/Navigation; (10) Publication/Documentation; (11) Safety; and (12) Training. In addition to these categories, there will be a discussion of other problems that were displayed on Tables 5, 6.1, 6.2, 10, 11.1, 11.2, 12.1, 12.2, 13, 14.1, 14.2, 21, 23, 24, 25.1, 25.2, 25.3, and 25.4. They had previously been identified as safety and human factors problems of the Sgt York Air Defense Gun System during DT II A and DT II B.

The discussion and conclusions in this section are based on the quantitative and qualitative data obtained and analyzed from the five sources identified in the Methods Section (General Description): (1) Data from the 1553 Data Bus; (2) video and audio tapes; (3) questionnaire responses; (4) structured interviews and observations; (5) RAM data and event logs.

PHYSICAL ENVIRONMENT AND WORKSPACE

The M48 chassis was not adequate for the Sgt York Air Defense Gun System. Not only were the crew compartments limited in space, but a redesign of the crew compartment would have been essential in improving the crewstation environment. Anthropometric redesign of the system for components, such as the brake pedal, throttle, head clearance, shoulder pads, etc., would have improved the work environment and ultimately enhanced the mission.

Many conditions associated with the physical environment and workspace contributed to the degradation of crew performance. It was indicated that varying degrees of degradation occurred due to noise, temperature, air quality, workspace, and crew comfort. Of particular note was the lack of space for knees and feet for both the squad leader, as well as the driver. This problem was further exacerbated by the lack of stowage space resulting in NBC gear being stowed around feet and legs. The crewmen were confined to an environment where there was no natural position to place their feet. Because of the space limitation within the M48 chassis, crewmen experienced bruises on their knees from constantly hitting the instrumentation panel.

Overall, there was marginal storage space for Table of Equipment (TOE) items, clothing, and supplies. This would have had an impact during sustained operations (such as combat operations). The inadequacy of stowage and the inaccessibility of items would have degraded performance.

The cumulative effect of the physical environment and workspace problems would have negatively impacted on operational crew performance and system performance. There is the probability that when several minor problems are present in a system simultaneously, there will be a significant degradation in crew performance. Sustained operations of up to 72 hours or more would have magnified the physical environment and workspace problems beyond what had been documented from the FOE I.

WORKSPACE, ANTHROPOMETRICS, COMFORT

Issues of comfort and discomfort were examined for their association with fatigue in general, and physical stress, as well as mental stress factors. A further discussion of the workspace within the M48 chassis provided the context for issues of fatigue which resulted during limited operations of short duration within this work environment.

Lack of adequate workspace was one of the major concerns of the crewmembers for the Sgt York Air Defense Gun System. Only minimal space was provided for the squad leader, gunner, and driver. The driver's compartment was cramped and awkward. For example, only marginal leg room existed for drivers when they operated "buttoned up." During FOE I, all drivers stated general dissatisfaction with the workspace within the driver's compartment. The level of dissatisfaction was even more pronounced for larger percentile drivers. Measurements of the driver's compartment indicated that the compartment size did not meet MIL-STD-1472B requirements.

The position of the brake pedal was another problem with which drivers had to contend. The brake pedal was located above and to the left of the accelerator pedal. The steering column inhibited leg movement from the accelerator pedal to the brake pedal. Many drivers, especially those with longer legs, hit their legs on the steering column each time they depressed the brake pedal. In addition, because of the location of the brake pedal in relation to the accelerator, there was a safety hazard in that the driver's foot sometimes slipped off the brake pedal and onto the accelerator pedal.

Workspace was just as cramped for the squad leader and gunner. The turret compartment provided only minimal space. The lack of knee and foot room in the turret compartment resulted in crewmen with bruised knees. They suffered bruised knees while traveling over rough terrain, and from hitting their knees on the instrumentation panel when the turret slewed.

The vehicle suspension system was not adequate for traversing rough terrain during extended movements. Crewmembers experienced a bouncy ride. Drivers were equipped with only a lap belt. Several drivers indicated that they would also prefer a shoulder harness. Squad leaders and gunners were equipped with inertial reel shoulder harnesses to prohibit rapid body movement forward. There were instances when the inertial reels failed to hold the squad leaders and gunners, and they came flying forward in their seats.

The crew compartment seats were considered a primary source of discomfort. During the FOE I 30-minute trials, crewmembers rated their seats as uncomfortable, with a lack of cushioning and support. As the squad leader and gunner would lean forward to operate the system, the crew compartment seats provided little lower back support. Crewmembers indicated that the discomfort experienced with the seats would have an accumulative effect. One gunner, during the Force-on-Force phase, went so far as to construct his own cushion to alleviate the problem. Gunners and squad leaders both commented that they could not move their seats close enough to the instrumentation panel because there was no room for their feet. This resulted in the turret operators leaning forward during much of the tactical operations, with no support for their lower backs.

Crewmen gradually developed cramps and fatigue due to the cramped, awkward positions they were required to maintain during operations. These conditions were magnified by the cuts and bruises they received as the Sgt York bounced around over the rough terrain. There were numerous sharp edges and corners in the driver and crew compartments. These sharp edges and exposed threaded bolts caused the cuts and scrapes. During FOE I, one driver received a 4-inch cut on his right hand while reaching to turn a switch. This problem was exacerbated when the turret made violent slewing actions during tactical operations. Gunners indicated that the corner on the receiver stalo hit their shoulders each time a sudden slew to their left occurred. Squad leaders had the same painful experience with the edge on the secure radio in sudden slews to their right. During Force-on-Force, one squad leader received a cut on his elbow as the turret slewed suddenly.

While the Sgt York traversed rough terrain, there was also the possibility of other injuries in addition to the scrapes, cuts, and bruises previously identified. Squad leaders commented that there was a lack of padding around the squad leader's hatch. Some squad leaders improvised padding by attaching a thick strip of foam rubber wrapped around their midsections. The foam rubber absorbed some of the shock.

Configuration of the driver's compartment was a flawed design, whether in the hatch-open or hatch-closed mode. This has been a generic problem with the M48/M60 tank series. With the hatch closed, the driver is placed in an awkward position

where the vehicle cannot be driven effectively. Discomfort to the back, neck, legs, and shoulders are experienced when the hatch is closed. When the hatch is open, the drivers have more room, and are able to sit in a more relaxed natural position. However, with the hatch open, drivers risk having their heads hit by the turret each time it slews. They also risk suffering hearing damage when the guns fire.

In a separate test conducted at the conclusion of FOE I, the emergency egress was evaluated. The results of that test are discussed in the Results section of this report. During the test, crewmembers established that egress through the gunbay was possible, but only when the turret was facing aft. Crewmembers found that opening the turret floor door from the crew compartment presented an access of 9 inches. This was inadequate for personnel in MOPP 4 gear to reliably pass through into the driver's compartment. The hinged turret floor was restricted from opening further by the M3 submachine gun mount on the left side of the firewall assembly. Removing or changing the mount would have increased the opening to a more acceptable size. Without such a change, the entire firewall assembly had to be removed, since the floor door hinges were now held captive (unlike earlier designs) by the firewall. (One tested crew was able to perform the firewall/floorplate removal and evacuation through the driver's compartment in 3 minutes, 9 seconds.) If these pins had not been captive, the turret floor door could have been more easily removed, which would have speeded up the entrance/exit/evacuation of the driver through this access.

Other problems identified in the category Workspace, Anthropometrics, Comfort deal directly with design issues related to tools and storage. The poor design of tools was an issue. During DT II A, the hammer tension nut tool was identified as having a poor design. The hammer tension nut tool was used for manually charging the guns. It was a crank type of tool that could only be turned one-half turn at a time. It was recommended in the DT II A report that the hammer tension nut tool be replaced/modified with a ratchet handle. With this change in design, constant removal from the shaft while manually charging the guns would not have been necessary. During FOE I, the findings revealed that no action had been taken.

In another instance, it had been determined during DT II B that the ammunition handling tool was not adequate for pushing the rounds into the feeder during loading. Crewmen were pushing the last round down with their hands or feet since the ammunition handling tool was not useful in performing this function. Subsequently, the ammunition handling tool was redesigned, and was no longer considered a problem. However, during FOE I, there was a shortage of these tools for training, as well as for field testing.

The design of the crew compartment impinged on the storage and wearing of NBC gear. Several problems associated with storage/wear were identified by Sgt York crewmen during FOE I. The crew compartment was not designed for the storage or wearing of NBC gear. The sharp edges and points found within the crew compartment caught on the material and tore the gear. This occurred both during storage and while wearing the NBC gear.

Since the crew compartment was not designed to store the NBC gear, the crewmen stowed the gear anywhere they could find a place for it. For example, turret operators stowed the gear over the azimuth drive motor or behind the seat. Drivers placed their gear alongside fire extinguishers or behind the seat. NBC gear stowed in crew compartments frequently became contaminated by hydraulic fluid. Hydraulic lines leaked onto the gear and resulted in making the NBC gear unusable.

To alleviate the stowage problem and reduce the time it took to don the NBC gear within the crew compartment, the tactical standard operating procedure specified suiting up partially before entering a vehicle. If NBC gear was likely to be required during a mission, crewmembers would wear the suits around their legs for a low-order MOPP. For a higher level MOPP, the suits were pulled up, and the masks and gloves were donned. FOE I trials conducted in NBC gear started out initially with crewmen wearing their NBC gear around their ankles and lower legs with their booties on. When warned of an NBC environment, the crewmen pulled their suits up and donned their masks and gloves.

Sgt York crewmembers indicated that inadequacies of the crew and driver compartments were accentuated by operations in NBC gear. Long periods inside the crew and driver compartments were especially fatiguing. Other conditions which aggravated fatigue were long, dusty road marches and night operations.

The degree of fatigue experienced by Sgt York crewmembers during FOE I was directly related to the following factors: time/length/number of trials per day, trial design (NBC/ambient environment, stationary/traveling operation), climatic conditions (dust, temperature), and crew comfort. The Force-on-Force and Live Fire crews experienced differing degrees of fatigue depending upon which combination of the above factors was involved. Although actual missions during FOE I lasted approximately 30-45 minutes, crewmembers spent 2 to 3 additional hours inside the Sgt York for each mission. The original test design plan called for the FOE I crews to man the system for extended periods of time (16-20 hours). Comments from the crewmembers indicated that under those circumstances, fatigue and stress would have become major areas of concern. Prior to FOE I, the participating crews had no opportunity to spend extended periods inside the Sgt York.

Other factors which degraded the crew performance were air quality, nausea, temperature, and possibly noise. Air quality was a problem in the driver's compartment, but not in the crew compartment. During both the Force-on-Force phase and the Live Fire road marches, drivers complained of dust entering their compartments. Several drivers wore cloth bandannas over their faces to filter some of the dust. Squad leaders and gunners indicated no problems with dust or fumes entering the turret compartment. After a Live Fire road march, one driver commented that he experienced a burning sensation in his lungs from all the dust he had inhaled.

Road marches were found to induce nausea for some individuals. Three gunners reported brief bouts of nausea but no vomiting at the beginning of long road marches (approximately 60 miles, and 3 to 4 hours in duration). Three crews completed two such road marches, and two crews completed one road march during the Live Fire phase of FOE I. Two of these gunners indicated that the nausea was neither severe in degree nor long in duration. It was attributed to their inability to see where the fire unit was going; movement over rough, dusty terrain; heat; and lack of fresh air. The third gunner blamed a large lunch he had eaten immediately before the road march began.

Road marches and long periods within the fire units during FOE I had a negative effect on crew performance as related to temperature. The environmental control unit (ECU) supplied air to the crew compartments. Eighty percent of the crewmembers participating in FOE I (9 squad leaders, 8 gunners, and 7 drivers) indicated dissatisfaction with temperature control. During long trials and road marches, the crew compartments got hot. The condition was exacerbated when the crews donned MOPP 4 gear. Crewmembers commented that cool air was directed to the protective masks via the Chemical/Bacteriological/Radiogical (CBR) fan, but there were no means of directing air through the MOPP outer garments. Crewmen quickly became hot and uncomfortable. During the Live Fire phase, one fire unit's CBR fan failed to operate. The crew continued to participate in the mission in MOPP 4, but was extremely hot and uncomfortable. The squad leader commented after the trial that operating in MOPP 4 without the CBR fan could very quickly lead to dehydration.

Noise was one factor that did not seem to be a problem during operation of the fire units. One crewmember did comment that the turret compartment was too noisy. However, most crewmembers indicated that the noise level in the crew and driver compartments was acceptable. Crewmembers wore their helmets while operating the system to block out noise generated by the primary power unit (PPU) and other mechanical and hydraulic subsystems. The helmet also allowed crewmembers to communicate with each other.

Many factors increased the level of fatigue and discomfort for crewmembers. Air quality for drivers was an issue due to the inhalation of dust during the road marches. Brief episodes of nausea were experienced at the beginning of long road marches. Crew compartments were extremely hot during the road marches. There were temperature control problems with the environmental control unit. The combination of factors placed crewmembers in a physically stressing environment.

Other physical aspects of the fire unit had ramifications that induced mental stress. This was illustrated by responses to questionnaires and debrief forms where drivers were placed in a stressful situation when they were operating heads-out and the turret was free to slew. Each time the turret slewed while they were heads-out, there was the possibility of the turret hitting them on the helmet. All drivers during FOE I were struck in the head as the turret slewed at some point during the test. In addition, drivers felt quite a bit of stress when trying to maneuver the vehicle with their hatches closed.

Mental stress induced during FOE I was experienced by squad leaders, gunners, and drivers. Squad leaders and gunners cited specific events, such as losing external communications, the inability to locate ground targets quickly during the Live Fire phase, (incorrect azimuth readings from the command post), and test limitations which forced them to prematurely terminate engagements, as being very stressful. All FOE I crewmembers, especially those involved in the Live Fire phase, felt additional stress from the political exposure of the test.

CONTROLS AND DISPLAYS

Difficult-to-operate controls may present obvious dangers or decrease efficiency for operator workload. For example, squad leaders experienced difficulty operating their removable control grip while in the heads-out position. The squad leader's right control grip was removable so that he could continue to control operations while heads-out. Several squad leaders remarked, both on the questionnaire and during post mission debriefs, that the control grip was difficult to operate without any support. It was suggested that a mount be placed just outside the squad leader's hatch into which the removable grips could be quickly inserted/removed when the squad leader was operating heads-out.

There were other problems identified with control grips. Crewmembers in the turret had to keep their hands on the control grips for extended periods of time in order to control the turret and successfully perform tactical operations. Operators expressed dissatisfaction with the fixed position of the control grips. For some, the control grips were too high and caused discomfort and fatigue. It was suggested that the control arm, upon which the grips were mounted, be made adjustable. Operators could adjust the control grips to personal

preference, thus reducing the amount of discomfort and fatigue. Specific recommendations to improve the control grip were to stabilize the squad leader's control grip during the "heads-out" condition, to add a communication control to the control grip, and to add an adjustable control arm.

Controls on the squad leader and gunner hand grips were identical, with the exception that the squad leader controlled an override capability. With this capability, it was possible to disable the gunner controls. In all other aspects, the functions of the controls were the same. Individual functions could not be locked out at either station. It was predictable that conflict between control operations would arise. Two sets of controls with similar functions, operated simultaneously by two crewmembers, controlling one piece of equipment, was a questionable design of the controls on the hand grips, as well as an ambiguous division of labor.

When the squad leader used the slave designate or lased a target, the gunner hand grip controls were disabled, except for the pointer on switch and thumb tracker cursor control. The controls remained disabled until the squad leader activated his "FREE" switch or otherwise took action to deliberately relinquish control of the turret. Several instances were observed where the squad leader activated the "SLAVE" switch, then got distracted by another task and neglected to activate the "FREE" switch. In most cases, this occurred during a handoff of a target to the gunner, who immediately became aware that his controls were inoperative and reminded the squad leader (at times quite emphatically) to release control of the turret. On some occasions, however, the squad leader hit slave or attempted to lase a target, and for some reason did not hand the target over to the gunner for engagement. The mode in these instances remained in squad leader slave for several minutes until the gunner attempted a control action and nothing happened. Typically, the gunner would attempt the control action several times. The squad leader then attempted the action. In some cases, the squad leader slave mode was terminated through the control action itself. Function allocation for squad leader and gunner regarding the controls on the hand grips should have been reexamined and modified to benefit target acquisition. Several instances of operator error leading to inoperable controls or ineffective control actions were observed. The primary cause of these incidents could be traced to the design of the controls themselves, rather than to a lack of knowledge or training on the part of the crewmembers.

Some of the displays were distracting and disrupted communication. To control the auditory displays, as well as facilitate communication, controls for variable volume could have been incorporated. Glare from sunlight on displays, including the plasma display, was pronounced when the squad leader's hatch was open. The time it took to place the pointer on the target was increased due to the glare. Acquiring a sun screen

for the plasma display would have been useful in reducing glare.

WORKLOAD/DIVISION OF LABOR

Division of labor and workload was a problem for the squad leader of each fire unit. The division of labor ultimately affected the entire crew. This was a serious problem that had been previously experienced by M48 and M60 tank crews. Sgt York drivers reported considerable difficulty negotiating terrain encountered at Fort Hunter-Liggett while operating under armor. Such drivers relied upon the squad leader for assistance in movement, which represented an additional burden for an already busy squad leader. It had been determined that Sgt York drivers did not receive adequate training in the type of driving conditions found at Hunter-Liggett.

Drivers were forced to place greater reliance on squad leaders. When the workload of the squad leader increased, this had a negative effect on system reaction time. While drivers were maneuvering in the hatch-closed position, squad leaders were guiding the drivers through "heads-out" operation. This caused difficulties for the squad leaders in monitoring communication nets and tactical tasks. A cascading negative effect was that the interaction between the squad leader and gunner was degraded too. Reduction in squad leader navigation and communication tasks would have been beneficial since the gunner had to track, monitor display, and push the alarm reset button. If the squad leader was trying to direct the driver, and simultaneously handle all external communication, and detect and approve targets, there was the possibility that there would have been missed engagements.

Another squad leader task that exhibited a workload problem dealt with loading ammunition. The squad leader was required to hold a flashlight with one hand and load a bulky, four-round clip of 40 mm shells with the other hand. Reloading was identified as a problem during DT II A, and had not yet been corrected at FOE I. The recommendation previously made during DT II A had been to mount two low-voltage lamps. They could have been mounted in explosion-proof fixtures with red filters. Installation could have been under the top of the turret, inside the magazine loading area.

As can be seen by these examples, problems related to division of labor and workload fell most heavily on the squad leader. Assisting the driver with navigation ultimately degraded the interaction and changed the division of labor between the squad leader and the gunner. Division of workload between squad leader and gunner was an important factor affecting the efficiency with which the Sgt York crews performed acquisition and engagement activities.

The system was originally designed with the concept that the squad leader would be the "hunter." The squad leader was to select targets to be engaged and assign them to the gunner. The gunner was to play the role of "killer" and to perform the actual engagement. In actual practice, however, it was found that both the squad leader and the gunner performed the functions associated with both roles. One crewmember actually interfered with the efforts of the other at times.

One major example of intra-crew interference was in the pointing actions. Both crewmembers could use the pointer cursor to select a target on the display to be acquired through a radar-pointer designation. This function would normally be assigned to the squad leader as the hunter. Across all trials and fire units, it was found that the squad leaders initiated 4,552 pointing actions, while the gunner initiated 3,672. Many of the gunner's pointing actions were attributed to the squad leader operating heads-out, leaving the gunner to perform both functions. During a trial, when the squad leaders operated mostly heads-in, fewer gunner-initiated points were observed. There were also instances when the squad leader and the gunner attempted to point a target at the same time. In such cases, the squad leader's action took priority, and the gunner's action was ineffective, so there was no real "interference." It did indicate some lack of coordination between the crewmembers concerning their task assignments.

Within one or two seconds after one crewmember had completed pointing a target on the display, the other crewmember would point a target, often the same one. Apparently, the crewman performing the second pointing action realized that the cursor was already on the target that he wished to point just as he depressed the pointer on switch, and immediately released it. This type of incident indicated that not only were the crewmembers duplicating each other's efforts, but to some extent they were not aware of what the other was doing.

The number of radar-pointer designations initiated by each crewmember was examined. Across trials and fire units, the squad leader initiated 1,787 radar-pointer designations. The gunner initiated 976 radar-pointer designations. This was indicative of the ambiguity in the division of tasks between the squad leader and the gunner, or of the flexibility of the design.

VISIBILITY

Fire unit drivers experienced continuing impairment of visibility from the driver's compartment. In the hatch-closed position, drivers had to rely on the vision blocks. Using the vision blocks, drivers were not able to see upward or downward. Side views were blocked by blind spots between the vision blocks. The driver's vision block had a limited field of view.

Drivers were only able to see out the front at a limited distance.

Since visibility was diminished, drivers drove slower than the normal rate of speed. When drivers were going up hills, they could only see the sky. Drivers could only see several feet ahead of the track when driving down hills. On one occasion, two crewmen received injuries when the fire unit ran into a ditch. Radars were damaged from hitting tree limbs, and two gun barrels were bent from hitting trees. Visibility from the crew compartment was inadequate. The periscope had a limited field of view, and the vision blocks had limited visibility.

Night visibility was a problem for the Sgt York crews. The goggles and imaging device in the driver compartment were inadequate. Thermal sights for the driver should have been investigated. A wider field of view and magnification would have been useful to crewmembers.

Skirts and splash guards were suggested as a way to reduce the amount of dust and mud on vision blocks. The tendency of vision blocks to become splashed and muddy during operations at water crossings has been common to the M48/M60 chassis. Another common problem has been the obscuring dust thrown up by the tracks. Drivers during FOE I had to stop and wipe mud from their vision blocks so that they could continue operation of the Sgt York fire unit.

Visibility problems were magnified while crewmembers were wearing NBC gear. Gunners were not able to get close enough to the sight with their masks on. Depth perception was distorted. Targets appeared to be farther away than they actually were. This made it more difficult to acquire targets.

AUDIO AND VISUAL ALARMS

Problem areas were identified with the engageable target alarm and alarm reset button. The alarm reset button was difficult to activate and to reach. Squad leaders and gunners had to remove their hands from their control grips to reset the alarm button. If the squad leader was operating heads-out, then the gunner had a long reach to activate the reset button. This placed a greater task loading on the gunner.

It would have been possible to relocate the alarm reset button so that it would have been an easy reach for the squad leader or gunner. Another option would have been to include two alarm reset buttons. There could have been one button for the squad leader and one button for the gunner, or two reset buttons for the squad leader (one for the squad leader in hatch, and one for the squad leader out of hatch). To eliminate the need for two alarm reset buttons, the alarm could have been modified with an automatic shut-off which would activate after several seconds.

TARGET DETECT/ACQUISITION/TRACKING

Visual problems were identified during the Live Fire trials of FOE I for target detection, identification, and acquisition. Live Fire targets were obscured by dust and smoke. In addition, laser return was degraded by dust and smoke. Motion and vibration was a problem in the crew compartment. Motion and vibration degraded the gunner-browpad interface. Because of this condition, lasing on the move was extremely difficult.

During the Force-on-Force trials, misidentification of aircraft via the IFF system was a concern of crewmen. The misidentification of friendly aircraft may have been attributable to a bias toward calling designated aircraft foes in cases of ambiguous identification (in combat, perhaps a realistic bias). The system was supposed to ID targets automatically as they were detected and display only foes (in the display mode normally used). Therefore, the crewmembers might have been more reluctant to call any displayed and designated target a friend than to call it a foe in cases where visual ID was difficult.

Another possible factor regarding misidentification was the emphasis on identification of foreign aircraft in the aircraft recognition course. Since both hostile and friendly aircraft were played by U.S. aircraft, crewmembers may have been somewhat confused about which was which. During interviews and debriefings, some crewmembers did seen somewhat unsure of the nomenclature of the aircraft flown in the trials.

Across trials and fire units, a total of 134 designations were paired definitely with friendly aircraft (both fixed- and rotary-wing), 530 with hostile fixed-wing aircraft, and 156 with hostile rotary-wing aircraft. Of the designations of friendly aircraft, 43 (32%) were terminated using the friend switch. There were 13 friend breakoffs from hostile fixed-wing aircraft, and 8 friend breakoffs from hostile rotary-wing aircraft. Given the 63% (1960/3123) rate of "no contact" after designation, breakoffs by other methods (breakoff, slave, or designate a new target) were attributed to the crewmember not being able to see the aircraft designated. They were not able to visually ID the aircraft.

If half the "no contact" breakoffs were assumed to be due to designation of false returns, giving an estimated rate of 31% for no contact breakoff on 69% real targets, then positive contacts should have been made on real targets: approximately 92 (.69x134) friendly, 366 (.69x530) hostile fixed-wing, and 108 (.69x156) hostile rotary-wing aircraft. The friendly breakoff rate for positive contact with friends would be estimated at 47% (43/92), and would be 4% (13/366) and 7% (8/108) for hostile fixed and rotary wings, respectively. The friend breakoffs from the hostile aircraft appeared to be due to

erroneous visual ID of those aircraft. A small number might be due to using the friend switch by mistake after classifying the target as hostile.

One of the most important findings was that in 1,960 target designations out of a total of 3,123 (63%), the reason for ending the acquisition/engagement sequence was "no contact," i.e., no target was found at the location indicated on the plasma display. There are several possible explanations for the phenomenon: (a) designation of false returns, (b) designation of targets with short intervisibility periods, and (c) long crew reaction times. The designation of false returns may be questionable since the incidence of no contact breakoffs is almost the same in benign trials (62.9%) as in ECM trials (62.7%). Under ECM conditions, more false targets would be expected to occur. However, crewmen stated that they could tell false returns from real targets, and these data indicated that this might have been true in most cases.

In the area of target identification and classification, it was extremely important that the crewmembers learn to use the friend switch properly. Once acquisition on a particular search file was terminated using it, that search file was classified as friendly and could not be redesignated unless the IFF override was used. A target was being tracked by the gunner when the squad leader determined that another target required immediate attention, and pointer designated it. At about the same time as the squad leader's designation, the gunner visually ID'd the target as friendly and activated his friend switch. Since the friend breakoff occurred a fraction of a second after the designation, the result was that the designation of the new target terminated the first engagement, and the friend breakoff terminated the second engagement. Not only was the second engagement terminated prematurely, but that track file now had a classification of "friend," making it ineligible for designation unless the IFF override mode was selected.

The subsequent efforts of the squad leader to redesignate the second target were automatically terminated by the Fire Control Computer (FCC). The target masked before the squad leader could determine what had happened, and go to IFF override. It was highly probable that the crew never figured out what happened, and concluded that it was a system malfunction. Similar incidents, with activation of the slave or breakoff switch instead of the friend switch, were observed. In these cases, the second target could be immediately redesignated so the consequences were not quite as serious.

There were many observations of apparent confusion stemming from a lack of positive indication of whether the system was in the engage mode or not. The FCC terminated engagements frequently for various reasons. The most common reason was masking of the target with consequent loss of the search file,

or a positive IFF response on the designated target. Out of 201 cases of termination by the FCC, 138 were followed by an unnecessary manual breakoff action. In nearly all of the cases where the manual breakoff action occurred, the reason for breakoff was stated as "no contact" with a target. Data indicated that the crew was not aware in most cases of FCC terminations. The crew believed that the system was still in an engage mode. This impression was reinforced by the continued display of the pointed target symbol. In many cases, pointer designations were terminated by the FCC because the search file had been lost. A positive indication was needed on the display, in the gunsight, and in the periscope. To indicate that the system was in an engagement mode, symbology should have been terminated at the same time that the search file was dropped.

Other observations indicated that crewmembers held down the radar-pointer switch until positive contact was made or a "no contact" decision was made. In the case of an attempt to designate a search file which was dropped subsequent to being pointed, the system would alternate between pointer designation and FCC termination in 0.2 second cycles until the radar-pointer switch was released. Crewmembers also repeatedly designated the same pointed target and broke off when no contact was achieved. Apparently they attempted to force the system into an acquisition. These activities indicated that the crewmembers had some misconceptions about what the system actually did in response to the designate switch action.

The fire enable cue light was more likely to flash intermittently when the laser was not employed. Crewmembers were prompted to wait until they got a more definite cue before firing. The result was that 50% of the radar auto designations that reached fire enable were fired upon. Over 66% of the radar-pointer designations were fired upon. Almost 80% of the optical designations were fired upon.

Another problem which occurred several times was related to changing correlations between the track file and the search files. A particular search file would be designated, and then the track file would begin to correlate with a search file other than the one originally designated. At breakoff, if the pointer had been left on the original display symbol, that target would have been immediately redesignated. Then the same change in correlation could have taken place. This cycle repeated several times until the pointed file was either dropped or de-pointed. This type of occurrence wasted time. It was potentially confusing to crewmembers who expected that after breaking off a designated target, the same target would not be automatically redesignated.

A viable expectation was that there would have been a large number of "no contact" breakoffs in normal operations even with well-trained crews. This is due to multiple factors

such as: (1) large number of extremely short intervisibility segments, (2) delays in displaying targets after detection, (3) delays in servicing one target because of the necessity to finish servicing a previously designated target.

Breakoffs were less frequent for fixed-wing targets since intervisibility segments for fixed-wing aircraft were much longer than for rotary-wing. A higher percentage of designations for fixed-wing aircraft would have been expected to result in successful acquisitions. This can be illustrated by the fact that out of 321 reaction designations of hostile fixed-wing targets, 37% resulted in trigger pulls. Out of 99 reaction designations of hostile rotary-wing targets, 26% resulted in trigger pulls. However, when these results were quantitatively analyzed, it was determined that the difference between reaction designations for fixed-wing and rotary-wing targets and percentage of trigger pulls was not statistically signi-ficant.

Some of the failures to acquire an aircraft following designation was explained by the short duration of intervisibility segments. However, there was a small percentage of designations occurring less than 1 second after the start of intervisibility. In most instances, there were long crew reaction times to the start of intervisibility. A contributing factor to long crew reaction times was the slight delay between the start of intervisibility and the first display of the target. For hostile rotary-wing aircraft, 76% were displayed within 4 seconds of start of intervisibility. Over 50% of the rotary-wing aircraft displayed within the 4 seconds were actually displayed in less than 1 second.

A large percentage of intervisibility segments would have been on the verge of ending when the target was first displayed. This was because of the large number of short-duration hostile rotary-wing aircraft intervisibility segments. For example, 48% of in-range targets were displayed for less than 5 seconds plus time of flight. About 33% of the durations were 4 seconds or less for rotary-wing targets between designation and end of intervisibility. These targets would have been masking at about the same time the slew was completed. The crews might have never even seen some of the targets unless the gunsight had been originally pointed directly at the target. Clearly, the Sgt York system detected many more targets than were displayed to the crew. Many of the targets that were displayed to the crew did not remain on the display long enough to be engaged. The crews had to examine and eliminate many possible targets to select the relatively few targets that they engaged.

COMMUNICATIONS

Communications problems were frequently noted during Force-on-Force and Live Fire early trials. Sgt York fire units had receive/transmit access to the platoon net, and receive-only access to the early warning net and the supported unit net. Debriefing comments after the early Force-on-Force trials frequently noted that there was too much external communication coming into the fire units on these three nets. It interfered with internal communication among the three crewmen. It was particularly noted that the squad leader's directions to the driver in choosing routes for movement and avoiding obstacles were interfered with. In a few cases, squad leaders reported that they had simply turned off the receive-only communication on the early warning net and the supported unit net.

Debriefing comments after several of the later Force-on-Force trials noted that there had been good communication during these trials. Analysts listened to the communication on the crew activities videotapes for several of the early trials, and determined that the communication was not excessive or irrelevant. Examination of the audio transcripts for later trials indicated that the nature and amount of communication had not changed from the earlier trials. What had apparently changed was the Sgt York crewmen's perceptions of the communication. After a few weeks of working with it, they were better able to deal with the communication. The crews then reported "good" communication.

Communications jamming was used during FOE I. Communications jamming occasionally disrupted operations. However, usually the crews were able to work around it. For example, it was noted that during six different trials, communications jamming occurred, but did not degrade performance. This was attributed to the fact that the system was switched to high power, and the crew was able to work through the jamming. Four out of five Force-on-Force squad leaders reported on the questionnaire that there were occasions in which communications jamming was effective, but examination of the post-trial debriefing comments showed that during most of the trials, communications jamming did not give the crews any trouble. Communication jamming was most effective when it occurred immediately after the crew keyed their microphones.

Squad leaders spent 15.5% of their trial time during Force-on-Force talking with the driver. Virtually all of this time was spent directing the driver around nearby obstacles. This required the squad leaders to be heads-out, and their attention was directed away from the immediate air battle. It was also noted that the squad leader spent less time talking to the driver during the road march scenarios than during attack or delay-type trials. It was interesting to note that squad leaders spent less time communicating with gunners than with drivers (14.3% vs. 15.5%). The large amount of time squad

leaders spent talking to drivers was in part the result of poor visibility in the driver's compartment.

Squad leaders had to interrupt target acquisition performance frequently in order to operate the headset control. The primary burden of internal and external communication was assigned to the squad leader. The squad leader was required to remove his hand from the control grip to operate the headset control. This often interrupted or delayed performance on engagement tasks, and degraded combat effectiveness. Squad leaders and gunners from four of the five Force-on-Force crews commented on this problem in debriefings. It was also noted in comments on the questionnaire administered near the end of the Force-on-Force phase of the test. Crewmen frequently noted that a foot switch or a switch that did not require taking their hands off the grips would solve this problem.

TRAVEL/NAVIGATION

Travel/navigation problems were reported during Force-on-Force and Live Fire by all Sgt York crews. Variables contributing to the travel/navigation problems were multiple. This can be illustrated by some of the following examples. There were blind spots between the vision blocks. Full-length vision blocks might have alleviated this problem. When drivers wore laser glasses or face masks, their visibility was impaired, and travel/navigation degraded. Sgt Yorks were required to travel in close proximity. Dust was generated by lead fire units. This obscured the vision of the drivers in the trailing units. Drivers also commented that they were not able to see anything at night while negotiating rough terrain.

Because of the driver visibility problems during travel/navigation, squad leaders took over navigation tasks from the drivers. Squad leaders increased their workload by assisting the drivers in navigating over new terrain, guiding drivers, communicating with platoon leaders, and detecting targets. Squad leaders spent over 15% of their time directing the drivers.

Driving conditions were further degraded by water and mud. When drivers elected to drive hatch open for better visibility, they were soaked as it rained. Further complications developed from the rain since mud and water on the brake pedal made the fire unit increasingly difficult to operate and maneuver. The solution employed to eliminate the problems evolving from the mud and water was to travel/navigate under the "buttoned up" condition. The solution was impractical since the vision blocks were obstructed by mud (in any event, there was still the problem of the blind spots between vision blocks).

The drivers having been initially trained at Fort Bliss found the terrain more difficult to navigate at Fort Hunter-Liggett. The terrain at Fort Hunter-Liggett was rougher, and

the suspension for the Sgt York Air Defense Gun System was not adequate for the rough terrain. The Sgt York was found to be too slow to keep up with the M1 Battle Tank.

During the Force-on-Force trials, it was noted that the height of the fire units combined with the height of the antennas was too high to navigate the type of terrain found at Fort Hunter-Liggett. In order to avoid hitting trees, drivers were required to slow down and stow their antennas. Even with these precautions, there were antennas damaged, caused by hitting trees.

No data were collected on the performance of the system in maintaining ground situation data and battery status data. The 20-30 minute trial format and the narrow battlefield did not allow for the exercise of collecting data on the location of the task force and coverage of the sectors during the Force-on-Force phase of FOE I. Battery status data was not collected or evaluated for number of rounds left, DEFCON, and alert status.

PUBLICATION/DOCUMENTATION

As noted in the Results section, the operator and maintenance manuals were considered difficult to use. There were instances where procedures needed to be added to the manuals. In other cases, the manuals had been modified to include additional procedures. The technical manual encompassed many suitable warnings to avoid serious safety problems. There were 37 types of warning categories that could cause injury or death identified in the Operator's Manual.

To improve the operator manual, procedures for entry and exit could have been added. Specifically, the driver should have left his intercom box set to EXT (external) when he left the fire unit. This would have allowed contact with the turret crew through use of the external phone. In this way the driver would have been able to signal intent to re-enter the fire unit. There was no procedure for the driver to communicate his intent with the turret crew to re-enter the vehicle.

There had been a question regarding the suitability of warnings in the technical manual for the search radar and its radiation hazard. The technical manual specified that the operators secure a 13-meter safety radius around the fire unit before radiating. When the search radar and the track radar were both erect, and the search radar was rotating, maintenance personnel were aware that the system might be radiating. It was safe from a radiation hazard standpoint to approach the system at all other times.

Overall, the procedures and documentation remained difficult to use even after some modifications. However, the operators and maintainers had to work around a problem that should not have existed.

SAFETY

Various safety hazards have been described here along with ways of either reducing the level of hazard or eliminating the hazard entirely if possible. Safety issues addressed in this section deal with workspace in the driver's compartment, visibility, fire suppression, hydraulic lines and fluid, fuel spillage, excessive heat, restraints, sharp edges, hull hazards, physical injuries, and the accelerator lock.

Safety issues revolved around the cramped workspace in the driver's compartment. Resulting safety implications dealt with drivers experiencing bruised knees, sore backs, and slow reaction time in brake operation, insufficient leg and head room, and lack of adequate air circulation. The driver's compartment might have been too low. A splash guard could have alleviated the collection of water in the driver's compartment. There was a potential danger from hitting bumps and ditches when the driver's hatch was closed. Drivers were known to hit their heads on the hatch. The driver's emergency hatch also constituted a safety problem since it could only have been opened from the outside. The crew would not have been able to open the driver's emergency hatch from the inside if required. Other safety problems associated with the driver's compartment dealt with nuclear survivability, the rotating turret, and night operations. The compartment seals leaked, and rain water gathered in the driver's compartment. When drivers operated the fire unit with the hatch open, the rotating turret struck the back of their helmets. Drivers were hit on the head several times by the turret during operations. Prompted to drive with the hatch closed to protect their heads, visibility and maneuvering ability were degraded.

To avoid compromising the fire unit's safety, the infrared (IR) lights were not used at night. The Forward Looking Infrared (FLIR) systems on the AH-64 helicopters could easily have identified the IR lights. Without the IR lights, the drivers were operating the fire units almost completely blind.

Of special concern was the lack of an extinguisher system for the gunbay/ammo storage area. There should have been an automatic fire extinguisher in the gunbay similar to the one in the primary power unit. The portable halon extinguishers added to the crew compartment and driver's compartment were an important part of the fire suppression system. Fire alarms in the gunbay and main engine compartment would have been useful.

There were several complaints about hydraulic lines. Location of the hydraulic line in conjunction with the position of the crewmen (squad leaders) was identified as a potential problem for possible rupture of the line. Investigation of the hydraulic line indicated that the line was sufficiently protected. In the driver's compartment, there was leakage from hydraulic lines that resulted in a safety hazard. Hydraulic

fluid collecting in pools around the driver's feet caused the driver's feet to slip off the brake pedal onto the accelerator pedal. Leaks in hydraulic lines should have been eliminated through better design of coupling and improved fabrication of materials.

Squad leaders, gunners, and drivers all complained of heat. During one trial, the environmental control unit overheated, and the compartment got hot. An inoperable CBR fan also contributed to a hot work environment when for one crew in MOPP 4 gear. This created the potential for dehydration. Ex-cessive heat in the crew and driver compartments was considered a health and safety problem especially when operating in NBC gear.

Crewmember restraints were frequently identified as being inadequate. Shoulder restraints did not fully prevent forward movement, and the shoulder harness did not lock quickly enough due to a slow catch spring. The inertia reels on the shoulder restraints should have locked more quickly, eliminating slack in the harness. Additional safety features were suggested regarding restraints. A shoulder harness for the drivers along with the lap belt already in the system would have been useful. Restraints could have been installed for the squad leader for heads-out operations. Fastening of the gunner's shoulder harness to the hatch door needed to be redesigned. The current configuration of the shoulder harness fasteners would have prevented the hatch door from opening if the fire unit had been overturned.

Gunners and squad leaders commented frequently about the sharp corners on objects in the turret. The crewmen were frequently thrown against the sharp edges when the turret slewed. Sharp edges in the crew compartment should have been eliminated. The hull presented a safety hazard. The hull lacked sufficient handholds, and was slippery when wet or icy. Slipping or falling was a definite hazard. Application of a non-skid coating had been suggested after DT II A. This solution was rejected due to difficulty with NBC decontamination. The safety hazard remained with the definite possibility of slipping and falling.

Physical injuries to the squad leader were associated with the hatch, scope, radio mount, and brow pad. To avoid injuries, padding around the squad leader's hatch could have been useful. Bruises could have been reduced by repositioning the squad leader's scope. (Squad leaders were frequently hit on the shoulder by the scope.) Further bruises could have been reduced by repositioning the radio mount. Squad leaders were hit on the right shoulder by the radio mount. The secure radio mount protruded out too far. When the fire unit was mobile, squad leaders were concerned about the brow pad. Hitting a bump could mean hitting their foreheads. A face shield fitted

around the periscope and gunsight would have reduced or eliminated this problem while the fire unit was mobile.

Physical injuries to the gunner were associated with the environmental control unit, the gunsight stowage, and the periscope adjusting pin. A redesign of the environmental control unit could have increased accessibility of the ECU filter. There was the potential for laceration of the hand in accessing the filter. Injuries to the gunner's head occurred from hitting the gunsight. The gunsight required modification so that it could be stowed when not in use. The adjusting pin on the brow pad of the periscope projected directly toward the gunner. The adjusting pin should have been relocated to one side to prevent injuries.

A safety hazard was identified regarding the accelerator lock. During an examination of the driver's compartment, it was determined that the vehicle was equipped with two accelerator locks. One was generic to the M48A chassis. A second lock was placed on the vehicle by FAAC. The original accelerator lock could only be used for coarse RPM settings, but it was not used. The second accelerator lock allowed the driver to set an accurate RPM output. When the vehicle engine was providing auxiliary power to the system, this accelerator lock was applied to keep output between 1900-2000 RPM. This charged the batteries, maintained hydraulic pressure, and prevented overheating. Drivers were instructed to apply the accelerator lock only when the vehicle was parked. There was the possibility of a driver applying the accelerator lock while the vehicle was moving. In a worst case scenario, if the driver set the accelerator lock to a certain RPM level while the vehicle was moving and then fell unconscious, the squad leader and gunner would have no means of quickly stopping the vehicle. This hazard also would have existed if the vehicle was moving and the driver's foot or a piece of clothing or equipment became wedged on the accelerator and if the driver became unconscious. A main engine "kill" switch in the turret compartment would have solved this problem.

TRAINING

FOE I training topics covered in this discussion shall focus on individual and collective training. MOS 16L, MOS 224D and MOS 24W training will be emphasized. Mention will be made of Force-on-Force and Live Fire Sustainment Training.

Individual training conducted for Sgt York crew operators/maintainers (MOS 16L 20/30/40 - T) had a critical modification of the program of instruction. Instructional time was reduced from the original allotted time by 55% in order to fit the training into the limited number of training days available. Considering the fact that the trainees only received about half of the planned instruction, over 80% of the trainees were still able to achieve passing scores of 90% or above. Even so, it is

clear that the trainees were convinced that instructional time needed to be increased. Crewmen receiving individual instruction indicated their view of the training by the following comments on questionnaires:

- Course not long enough - some areas (not defined) were rushed
- Numerous changes to course material were made during the training
- Not enough "hands-on" training - practical exercises were too short
- Experience with Electronic Counter Measures (ECM), i.e., what it looks like and what to do, was not provided
- Classroom trainer (SYCOFT) was not realistic when compared to the fire unit (FU)
- Some of the students had more experience on the FU than did the instructors

As with individual training, the trainees indicated that collective training should have encompassed more time. Suggestions were made by trainees to improve collective training in additional ways that included MOPP gear, firing practice, tactics, reloading, and jamming. The following comments were made by trainees regarding collective training:

- Not long enough - too much too fast
- Not enough MOPP clothing for all crews to practice NBC drills
- Firing practice was unrealistic - too many range restrictions
- Not enough understanding of tactics
- During reload - new loaders did not fit
- Numerous round jams - equipment and procedures to remove were not available
- Drivers had a limited amount of actual driving time

The adequacy of both individual training and collective training was investigated at the conclusion of collective training. Positive responses by crewmembers for ratings anchored between a +1 and +1.5 (verbal anchors equate with "good," "adequate," and "easy") indicated that there was a positive valence for collective training overall. Collective training received high ratings by crewmembers for Night Operations, Convoy Training, and Tracking Exercises. Training on the Fire Control Trainer (FCT) and the Gun Maintenance Trainer (GMT) was well received. Sgt York crewmembers rated their individual training from good to borderline.

Individual training rated by maintenance personnel received a high rating for Safety. Training received by maintenance personnel on the Gun Maintenance Training (GMT) and the Feed System Maintenance Trainer (FSMT) was well received.

Collective training received higher ratings by crewmembers and maintenance personnel compared to individual training. Crewmembers indicated that for individual training, readability was a problem for the operator's manual. The familiarization of firing at the conclusion of individual training was also rated low by the crewmembers. Maintenance personnel gave a low rating to the completeness of maintenance manuals used during individual training. There was consistency between operator and maintenance personnel in their need for improved manuals.

Additional data concerning collective and individual training were collected during Force-on-Force trials at Fort Hunter-Liggett. After each Sgt York trial, the three crewmembers were debriefed concerning mission events that had just occurred. One question asked was, "Were there any instances when individual or collective training did not adequately cover a situation which occurred during this mission?" Debriefing responses generally echoed the questionnaire comments:

- Not enough training on driving and maneuvering in trees, mud, and hilly terrain
- Inadequate driving experience using the night vision system
- Training with realistic ECM and how to respond to it
- Learning to operate with the supporting force
- Operations in smoke and dust
- Crewmembers recommended that a 3-day Field Training Exercise be added to the collective training plan

Maintenance personnel were requested to comment on their perception of collective and individual training. Some of their responses are presented:

- Too much talk and not enough "hands-on" experience
- Organizational Maintenance Trainer (OMT) wass useless
- Maintenance manuals were very incomplete - too many pages were to be determined
- Six of nine maintenance personnel felt their training was inadequate and that manuals should have better schematics
- Not enough PSE was available due to safety release restrictions
- Parts availability was a problem during collective training

<u>Maintenance Problems and Training</u>. Specific maintenance problems were identified during DT/OT and DT II A. These maintenance problems continued to exist during FOE I. Human factors engineering (HFE) findings from DT/OT revealed that there was not an external means to determine whether the radars were radiating. Maintenance personnel would have been unaware that the system was radiating. Operator and maintenance manuals tended to minimize the hazard. Procedures and training

should have been revised in the manuals to reduce the safety hazard for maintenance personnel.

Environmental Control Unit (ECU) filters were found during DT II A to be difficult to inspect and clean. HFE findings from FOE I suggested that the filters were so difficult to check that there was the probability that they would not have been checked on a daily basis when the vehicle was used in the field. The filters were located behind two access doors. The training manual had maintenance procedures for inspecting and cleaning the ECU filter which were difficult to follow and time consuming. A better method of accessing the filters needed to be established along with improved procedures in the manual. Maintenance personnel commented that the remove and replace procedures in the maintenance manuals were not always correct. The manuals were new for FOE, and the unit had been preparing modifications when errors were discovered. Approximately 25 modifications had been submitted. The manuals needed more theory and detail, including schematics, to allow logical troubleshooting when BIT failed to isolate the fault. The training manuals were not adequate.

Squad leaders and gunners indicated that they would be interested in performing routine maintenance tasks which were currently restricted to organizational maintenance. The maintenance tasks they identified were changing primary power unit (PPU) oil, cleaning air and chassis filters, performing boresight and battery maintenance. All squad leaders and gunners rated as adequate or very adequate the ease of use, completeness, and availability of tools and equipment at the operator level. There were several comments about the need for an onboard air compressor so that filters and equipment could be cleaned by the crews.

Maintenance personnel stated that they preferred to have assistance from crews in performing routine maintenance tasks. The maintenance tasks they identified were replacing minor hardware, weekly maintenance tasks identified in the maintenance manuals, and weekly maintenance on the feed hopper and cleaning the heater exchanger. They also indicated that the number of organizational maintenance personnel currently identified in the Table of Organization and Equipment would not be enough due to the large amount of time they must spend doing preventive maintenance.

Even though training and maintenance were discussed in this category, they were not part of the human factors test plan. Insufficient data collection and analysis during the FOE I human factors evaluation precluded an in-depth assessment of training and maintenance. Personnel selection also could not be assessed for similar reasons.

Many of the human factors problems identified in this discussion might have been alleviated with training that consisted of meeting a greater number of instructional tasks at criterion. This was precluded due to the abbreviated training time allowed for Sgt York crews and maintenance personnel. From the training data collected during FOE I, it is not possible to identify how well the training would have transferred to the field or especially to combat.

Appendix A

SGT YORK FOE FORCE-ON-FORCE HUMAN FACTORS DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.[1]

	TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE[2]	POSITIONS[3]	CREW ID #	TRIALS DESIGNATOR
1.	Driver Visibility	While operating buttoned-up, the driver has poor visibility due to the vision block's limited field-of-view. This has an effect on the entire crew since the squad leader needs to guide him. The driver should be allowed to operate in a head-out mode or install a full-length vision block.	64	S, D	1,2,3,4,5	1023,1025,1026,1028,1029,1030,1033,1034,1035,1036,1038,1039,1041,1042,1043,1045,1046,1047,1048,1049,1054
2.	Visibility from Crew Compartment	Visibility from the crew compartment is poor. The periscope has a field-of-view that is too small and the vision blocks have limited visibility.	42	G, S	1,2,3,4,5	1023,1025,1027,1028,1029,1030,1033,1034,1036,1041,1042,1043,1045,1046,1047,1048,1049,1054
3.	Workspace in Driver's Compartment	My right knee hits the shift lever, my shoulders hit the hull, and the vision blocks don't provide adequate visibility for driving buttoned-up. The time it takes me to hit the brake is slowed because I need to pull my knees up to my chest in order to reach the brake.	41	S, D	1,2,3,4,5	1020,1021,1023,1025,1026,1027,1029,1030,1033,1034,1035,1036,1038,1039,1041,1042,1043,1045,1046,1048,1054
4.	Access to Brake and Gas Pedals	The brake and gas pedals are too large. If the driver's foot slips, it's too easy to hit the wrong pedal. The brake pedal is difficult to apply due to its height and angle. I would suggest a T-bar acceleration/brake pedal.	32	D	1,2,3,4,5	1023,1026,1027,1028,1030,1033,1034,1035,1036,1038,1040,1041,1042,1043,1045,1046,1047,1048,1049,1054
5.	Seat Padding and Back Support	The gunner has to lean all the way forward to look through the sight; therefore, he has no back support and is very uncomfortable. More padding on the seat would help the backache problem.	30	G, S	1,3,4,5	1020,1023,1025,1029,1030,1033,1034,1035,1036,1038,1041,1043,1045,1046,1047,1048,1049
6.	CVC Switch	The CVC needs a foot pedal for radio communication. When lasing targets, both hands are needed on the hand grips.	27	G, S, D	1,3,4,5	1020,1021,1022,1023,1025,1026,1027,1029,1030,1035,1041,1042,1043,1045,1046,1047,1048,1049,1054

1. Only valid SGT York trials were considered in the frequency counts.
2. Approximately 100 additional comments with frequency less than 8 are not included.
3. G=Gunner; S=Squad Leader; D=Driver.

Appendix A (Cont.)

SGT YORK FOE FORCE-ON-FORCE HUMAN FACTORS DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.[1]

	TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE[2]	POSITIONS[3]	CREW ID #	TRIALS DESIGNATOR
7.	Radio Traffic	There are too many communications on the net. There are too many radios.	26	G, S, D	1,2, 3,4, 5.	1016,1018,1021,1022,1023, 1025,1026,1027,1028,1030 1033,1035,1038,1039,1040,
8.	Engageable Target Alarm	Internal communications are disrupted when the engageable target alarm goes off.	23	G, S, D	5	1015,1016,1018,1020,1021, 1022,1026,1027,1028,1029, 1030,1041,1042,1043,1046, 1047,1048,1054
9.	Commo Good	The commo was very good this trial.	19	G, S, D,	1,2, 3,5	1027,1028,1033,1034,1041, 1042,1047,1048,1049,1054
10.	Water and Mud Guard	The driver had to stop and wipe mud from his vision blocks. He feels that the vehicle should have wipers or some sort of shield to prevent mud from hitting the blocks.	15	S, D	2,3, 4,5	1020,1021,1022,1025,1026, 1030,1041,1042,1043,1045, 1046,1054
11.	Temperature in Driver's Compartment	Operating buttoned-up on a day like this (near 80 degrees) is hard on the driver. The driver's compartment gets too hot with the ECU having little effect. It's uncomfortable.	15	D	1,3, 4,5	1025,1026,1028,1034,1038, 1039,1041,1042,1043,1046, 1047,1048
12.	Commo Jamming Ineffective	Commo jamming occurred during this trial but did not degrade performance. The system was switched to high power and we worked through the jamming.	15	G, S, D	1,2, 3,4, 5	1016,1017,1021,1022,1023, 1030
13.	Glare on Plasma Display	When the squad leader's hatch is open, you get glare and dust on the display which slows your ability to put the pointer on targets. A sun screen is needed.	14	G, S	1,2, 3,4, 5	1018,1021,1022,1023,1025, 1026,1030,1035,1041,1042, 1043
14.	Storage Space	We need more room for the troops and storage of TA-50, NBC, and personal gear. As it is, we have to move gear before we can move ourselves around in the crew compartment. There is no place to put gear where it will not interfere with either the seats or the grips.	14	G, S, D	1,2, 3	1025,1026,1027,1030,1033, 1034,1035,1036,1038,1039 1043,1045,1046,1049

1. Only valid SGT York trials were considered in the frequency counts.
2. Approximately 100 additional comments with frequency less than 8 are not included.
3. G=Gunner; S=Squad Leader; D=Driver.

Appendix A (Cont.)

SGT YORK FOE FORCE-ON-FORCE HUMAN FACTORS DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTING IN ORDER OF DECREASING FREQUENCY.[1]

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE[2]	POSITIONS[3]	CREW ID #	TRIALS DESIGNATOR
15. Visibility With NBC Gear	Due to NBC gear, visibility through the sight was greatly hampered. The gunner couldn't get close enough to the sight with his mask on. Depth perception was distorted and targets appeared to be farther away than they were.	13	G, S, D	1,3,4,5	1027,1029
16. Crew Compartment Space	The gunner's compartment is too cramped and the seat is too hard. There is not enough room in the squad leader's compartment.	13	G, S	1,2,3	1021,1023,1026,1030,1034,1035,1036,1039,1043,1045,1046,1047
17. Squad Leader Workload	Sometimes the workload was too great for the squad leader. He had to navigate over new terrain, tell the driver where to go, communicate with the platoon leader, and detect and approve targets all at the same time.	13	S	1,3,5	1015,1016,1018,1021,1022,1023,1028,1038,1039,1049
18. Thermal Gunsight	There should be a thermal gunsight. Right now the gunsight is passive and requires at least a one-quarter moon to be effective.	11	G, S, D	1,2,3,4,5	1035,1036,1040,1041,1042,1054
19. Night Vision Devices	A more effective night vision device is needed for the driver.	11	G, S, D	1,2,3,4,5	1029,1040,1042,1049,1054
20. Driver's Seat Comfort	The driver's seat needs more cushioning in the bottom and back. I get sore from the long hours I drive buttoned-up. The driver's seat is too uncomfortable. The back needs to be adjustable so that his back can have support while he uses his periscope.	10	D	1,3,5	1030,1034,1041,1042,1043,1047,1048,1049,1054
21. Stress Due to Visibility	Not knowing where we were going at night in this rough terrain was very stressful. We could not see anything.	10	S, D	1,2,3,4,5	1028,1041,1042,1043,1045,1047,1048,1054
22. Temperature With NBC Gear	It got very warm (especially while operating in the MOPP-4 gear). It was tolerable, but I feel that in a warmer climate it would be a bigger problem. The gas particulate filter helped a little bit.	9	G, S, D	1,3,4	1022,1026,1027,1034

1. Only valid SGT York trials were considered in the frequency counts.
2. Approximately 100 additional comments with frequency less than 8 are not included.
3. G=Gunner; S=Squad Leader; D=Driver.

Appendix A (Cont.)

SGT YORK FOE FORCE-ON-FORCE HUMAN FACTORS DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTING IN ORDER OF DECREASING FREQUENCY.[1]

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE[2]	POSITIONS[3]	CREW ID #	TRIALS DESIGNATOR
23. Commo Poor	All communications seem very weak and hard to understand throughout the whole mission.	8	G, S, D	2,3, 4,5	1021,1028,1035,1036,1041, 1042,1045
24. Gunner Workload	When the squad leader went head out, the gunner found he had too much to do. Such as sound reset, visually monitor display, and use gunsight in order to maintain a solid track.	8	G	3,5	1015,1016,1018,1021,1022 1025,1026,1034
25. Commo Jamming Effective	The communication jamming was very effective. We couldn't receive anybody even when in high power.	8	G, S	2,3, 4,5	1015,1016,1018,1022,1023, 1029,1048

1. Only valid SGT York trials were considered in the frequency counts.
2. Approximately 100 additional comments with frequency less than 8 are not included.
3. G=Gunner; S=Squad Leader; D=Driver.

Appendix A (Cont.)

SGT YORK FOE FORCE-ON-FORCE SAFETY DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.[1]

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE	POSITIONS[2]	CREW ID #	TRIALS DESIGNATOR
1. Driver Visibility	The driver's vision block needs to be improved because it is a safety hazard. The driver can't see where he's going.	16	S, D	1,2, 3,4, 5	1027,1028,1029,1030,1033, 1035,1036,1040,1041,1042, 1043,1045,1054
2. Hit Head On Turret	On this particular mission, I hit my head on the turret several times.	12	D	1,2, 4,5	1015,1016,1018,1020,1022, 1028
3. Shoulder Restraints	The shoulder harness does not lock quickly enough. It allows you to go too far forward before locking. This is a big safety hazard. Also the harnesses have too much slack in them.	9	G, S, D	1,2, 3,4, 5	1035,1036,1040,1041,1042, 1043,1045
4. Sharp Edges in Crew Compartment	The receiver/stalo, positioned approximately shoulder height to the gunner's left, has sharp edges and corners which bruise the gunner when the turret slews very fast. All sharp edges in the compartment should be removed or padded.	6	G, S	1,3,	1020,1038,1040,1041,1042, 1043
5. Temperature With NBC Gear	The internal vehicle temperature is getting too hot. A safety problem will occur if NBC gear is used.	4	S, D	5	1015,1016
6. Suspension	The York's suspension is not adequate for the rough terrain here. It is more of a hazard when the driver cannot anticipate bumps and gulleys in order to slow down in time. Even with all safety restraints fastened, the crew is jostled around. The York is too slow to keep up with the M-1.	4	S, D	5	1025,1026,1029,1030
7. Safety Releases	The safety releases that have affected this test are a problem. I feel it should be up to the squad leader to determine when it is best to operate buttoned-up or when to use radar pointer. Too many safety releases inhibit performance.	4	S	5	1028,1029,1041,1042
8. Splash Guard	The driver's compartment is too low. When we hit water, it soaks the driver and accumulates in the compartment, making it hazardous to drive. My glasses were so muddy I couldn't see through them and had to take them off. A splash guard is needed.	4	D	2,5	1016,1021,1022

1. Only valid SGT York trials were considered in the frequency counts.
2. G=Gunner; S=Squad Leader; D=Driver

Appendix A (Cont.)

SGT YORK FOE FORCE-ON-FORCE SAFETY DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.[1]

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE	POSITIONS[2]	CREW ID #	TRIALS DESIGNATOR
9. Fluid in Driver's Compartment	There is hydraulic fluid in the driver's hatch which makes his feet slip off the pedals.	4	D	3	1021,1033,1036,1039
10. Hatch Restraints	Restraints should be installed for the squad leader for head-out operations. This will improve performance.	3	S	1,5	1015,1016,1018
11. Gunner's Shoulder Restraint	The gunner's shoulder harness is fastened to his hatch door in a way that, if the York ever flipped, would prevent the hatch from being opened.	3	G	4	1035,1036,1045
12. Driver's Hatch	With the driver's hatch closed, I banged my head. This is uncomfortable and potentially dangerous when hitting bumps and ditches.	3	D	1	1045,1046,1047
13. Squad Leader's Scope	The squad leader did not receive any injuries during this mission, but the scope hitting him in the shoulder is a frequent occurrence.	3	S	3	1021,1048,1049
14. Hatch Padding	The squad leader's compartment needs padding around the hatch, as injuries can occur the way it is set up now.	3	S	1,2	1021,1022,1025
15. Driver's Emergency Hatch	The driver's emergency hatch cannot be dropped from the inside. In a real emergency the crew would die inside as it can only be opened from the outside.	2	D	2,3	1021
16. Dust, Mud	Dust and mud are being thrown off the front tracks. It impairs the driver's vision and breathing, creating a safety problem. Skirts are needed to keep dust low.	2	D	1	1018,1025
17. Driver's Knees	The size of the compartment causes the driver to have severely bruised knees that never get a chance to heal.	2	D	1	1030

1. Only valid SGT York trials were considered in the frequency counts.
2. G=Gunner; S=Squad Leader; D=Driver

Appendix A (Cont.)

SGT YORK FOE FORCE-ON-FORCE SAFETY DATA. CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.[1]

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE	POSITIONS[2]	CREW ID #	TRIALS	DESIGNATOR
18. Radio Mount	The secure radio mount sticks out too far. I hit my right shoulder on it all the time and it hurts.	2	S	5	1021,1022	
19. Laser Inserts	The laser inserts for the MOPP mask used to protect our eyes are not safe. I can see light and don't feel protected from a direct laser hit on the gunner's sight. Also, when I move my head, I lose vision because of the way the frames are fitted.	1	G	4	1027	
20. Periscope Adjusting Pin	The adjusting pin on the brow pad of the periscope projects directly toward the gunner. It should be moved to one side. Today, the gunner had his head turned while they hit a bump, and the pin knocked off his CVC and hit him in the ear.	1	G	3	1033	
21. Brow Pad	The squad leader feels that there should be a face shield fitted around the periscope and gunsight that would permit him to safely press his face against them while moving.	1	S	4	1036	
22. Gunsight Stowage	The gunsight needs to be modified so that it can be stowed when not in use. This presents a safety problem, as it can hit the gunner on the head.	1	G	1	1039	
23. Fire Alarms	There should be fire alarms in the gun bay and the main engine compartment, in addition to the one already in the primary power unit.	1	UNDETERMINED		1033	
24. ECU Filter	The ECU filter should be made more accessible. There is the possibility of cutting your hand while trying to get at it.	1	G	3	1022	
25. Driver's NVGs	For night operations, the driver's NVGs are not adequate for driving in this terrain. The poor visibility through the vision blocks combine with this to make it very unsafe to drive in unfamiliar terrain.	1	D	4	1040	
26. Seals Leak	More work needs to be done on the driver's nuclear survivability compartment (NSC). All the seals leak as is evident by all the rainwater coming into the driver's compartment.	1	D	3	1022	

1. Only valid SGT York trials were considered in the frequency counts.
2. G=Gunner; S-Squad Leader; D=Driver

Appendix A (Cont.)

SGT YORK FOE LIVE FIRE HUMAN FACTORS AND SAFETY DATA.[1] CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.

	TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE	POSITIONS[2]	CREW ID #	TRIAL ID #[3] DESIGNATOR
1.	ECM Ineffective	The ECM had no effect on our ability to engage targets.	15	G, S	6,7, 8,9	12003,12004,12006,12007, 12010,12011,12012
2.	MOPP Gear No Problem	I had no problems operating in NBC gear.	12	G, S, D	6,7, 8,9	12003,12004,12006,12007, 12010,12011,12012
3.	Hot in MOPP Gear	It is very difficult to operate in MOPP gear. We cannot breathe normally and it is very hot.	11	G, S, D	6,7, 9	12003,12004,12010,12012
4.	Buttoned-up No Problem	I had no problems operating buttoned-up during this trial.	7	G, S	6,7, 8,9	12003,12004,12006,12007
5.	Good Trial	Everything went well during this trial.	7	G, S	6,7, 9	12003,12004,12007
6.	Radar Down	The radar failed.	7	G, S	6,8	12006,12012
7.	Dust	Large amounts of dust generated by long firing bursts caused degradation in visibility. The dust also hampered our ability to get a good laser return.	6	G, S, D	8,9	12007,12010,12012
8.	Division of Workload	The crew's division of duties works well as it is.	5	G, S	7,9	12003,12004
9.	Gun Jam	Our gun jammed. It was a magazine problem.	4	G, S	7,9	12011
10.	System Shut Down	While tracking a target, I hit the firing fan limit which shut the system down. I had to take steps to bring the system back up right in the middle of the engagement, which took some time (15-20 seconds).	3	G, S	6,7,	12006,12010,12012

1. There were no comments on training.
2. G=Gunner; S=Squad Leader; D=Driver
3. Trial ID # Key:

Trial ID#	Julian Date	Trial Type	Trial ID#	Julian Date	Trial Type
12003	154	AB(aerial)	12010	157	FA(aerial)
12004	154	AK(ground)	12011	157	FJ(ground)
12006	156	AA(aerial)	12012	166	A(aerial)
12007	156	AH(ground)			

Appendix A (Cont.)

SGT YORK FOE LIVE FIRE HUMAN FACTORS AND SAFETY DATA.[1] CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE	POSITIONS[2]	CREW ID #	TRIAL ID #[3] DESIGNATOR
11. Transmitting Problem	Our FU was not able to transmit on the radio.	3	G, S	9	12011
12. One-man Operation	A one-man York operation is possible, but the operator must pay particular attention to the plasma display.	3	G, S	6	12006
13. CBR Fan	The CBR fan did not work. There is a real potential for dehydration when in MOPP 4 gear with the CBR fan inoperable.	3	S	7	12004
14. Driver's Visibility	Vision blocks should be larger - perhaps a single 180 degree curve block. That would allow better peripheral vision.	2	D	7	12003,12010
15. CVC Switch	I had difficulty trying to keep my palm grips active and communicate at the same time. We should have some sort of system which frees my hands to perform tactical operations.	2	S	6	12006,12012
16. ECU Problem	The environmental control unit (ECU) overheated, creating a very warm compartment during the trial.	2	G	6	12012
17. Procedures	We acquired the fixed-wing target, but before we could fire at it the rotary-wing target appeared and the decision was made to break off the fixed-wing and engage the rotary-wing.	1	S	7	12003
18. Procedures	We disregarded a lot of false targets. Real targets appeared on the display in a consistent fashion and moved in a logical pattern. We used the radar pointer mode.	1	G	9	12010
19. Ear Plugs	I wore ear plugs and my ear-set, which muffled the sound of the guns firing, so I experienced no safety hazards.	1	D	7	12003

1. There were no comments on training.
2. G=Gunner; S=Squad Leader; D=Driver
3. Trial ID # Key:

Trial ID#	Julian Date	Trial Type	Trial ID#	Julian Date	Trial Type
12003	154	AB(aerial)	12010	157	FA(aerial)
12004	154	AK(ground)	12011	157	FJ(ground)
12006	156	AA(aerial)	12012	166	A(aerial)
12007	156	AH(ground)			

Appendix A (Cont.)

SGT YORK FOE LIVE FIRE HUMAN FACTORS AND SAFETY DATA.[1] CREWMEMBERS' DEBRIEF COMMENTS LISTED IN ORDER OF DECREASING FREQUENCY.

TOPIC	REPRESENTATIVE COMMENT	FREQ. IN DATA BASE	POSITIONS[2]	CREW ID #	TRIAL ID #[3] DESIGNATOR
20. Hearing	It is very difficult to hear while wearing the MOPP mask.	1	S	7	12004
21. MOPP Gloves	We didn't get a solid fire on one target. MOPP gear gloves probably caused the problem.	1	S	9	12004
22. Movement	When engaging the enemy "on the move", the driver had to be more alert to terrain and the squad leader had to be careful with the brow pad so that when there was a bump he didn't hit his forehead.	1	S	9	12010

1. There were no comments on training.
2. G=Gunner; S=Squad Leader; D=Driver
3. Trial ID # Key:

Trial ID#	Julian Date	Trial Type	Trial ID#	Julian Date	Trial Type
12003	154	AB(aerial)	12010	157	FA(aerial)
12004	154	AK(ground)	12011	157	FJ(ground)
12006	156	AA(aerial)	12012	166	A(aerial)
12007	156	AH(ground)			

Appendix B

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

COURSE: 043-16L20/30/40-T, SGT York Air Defense Gun System Crewmember (Transition)

TASK AND SUBJECT SUMMARY

1. PROPONENT - APPROVED TASKS FOR RESIDENT TRAINING:

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
441-066-1040	Visual Aircraft Recognition	TB1.10030	Yes	
441-067-1001	Pre-Set System Controls	SY2.21801	Yes	
441-076-1002	Perform Power Start-Up (Vehicle)	SY2.21906	Yes	
441-076-1003	Perform Power Start-Up (PPU)	SY2.21906	Yes	
441-076-1004	Perform Power Start-Up (Silent Mode)	SY2.21906	Yes	
441-076-1005	Perform Prepare for Action Procedures	SY2.23503	Yes	
441-076-1006	Operate Gunsight	SY2.23403	Yes	
441-076-1007	Operate Night Sights	SY2.23403	Yes	
441-076-1008	Perform Gyrocompass Start-Up	SY2.23308	Yes	
441-076-1009	Perform Readiness Check	SY2.23308	Yes	
441-076-1010	Perform a Rounds Count	SY2.23308	Yes	
441-076-1011	Perform Free Zone Procedures	SY2.23308	Yes	
441-076-1012	Perform Indirect Fire Procedures	SY2.23308	Yes	
441-076-1013	Perform Panels and Grips Checks	SY2.23308	Yes	
441-076-1014	Perform Turret-Gun Dynamics Check	SY2.23308	Yes	
441-076-1016	Load Magazines in Mag Load	SY2.24216	Yes	
441-076-1017	Load Magazines in Maintenance Mode	SY2.24216	Yes	
441-076-1018	Download Magazines	SY2.24216	Yes	
441-076-1019	Clear Jam During Magazine Load	SY2.24216	Yes	

*Yes=Trained to standard   F=Familiarization   NC=Not covered in resident training course

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
441-076-1020	Download Magazine in Maintenance Mode	SY2.24216	Yes	
441-076-1021	Terminate Mag Load in an Emergency	SY2.24216	F	
441-076-1022	Perform Laser Boresight Procedures	SY2.23503	Yes	
441-076-1023	Perform Field/Replacement Boresight Procedure	SY2.25902	F	
441-076-1026	Operate Squad Leaders Periscope	SY2.23403	Yes	
441-076-1027	Search for Targets with Optics	SY2.24704	Yes	
441-076-1030	Acquire Targets in Radar Auto Mode	SY2.24805	Yes	
441-076-1031	Acquire Targets with Radar Pointer	SY2.24805	Yes	
441-076-1032	Acquire Targets in Optical Mode	SY2.24805	Yes	
441-076-1033	Search for Targets on a Directed Azimuth	SY2.26304	Yes	
441-076-1035	Acquire Greatest Threat in Appropriate Mode	SY2.26304	Yes	
441-076-1036	Track Targets Using Optics	SY2.24907	Yes	
441-076-1037	Search for Targets with Radar	SY2.24704	Yes	
441-076-1038	Track Targets Using Radar and Optics	SY2.24907	Yes	
441-076-1039	Track Targets Using Radar Only	SY2.24907	Yes	
441-076-1040	Search for Targets with Optics and Radar	SY2.24704	Yes	
441-076-1041	Engage Air Targets	SY2.25011	Yes	
441-076-1042	Engage Ground Targets	SY2.25011	Yes	
441-076-1044	Terminate Engagement Sequence	SY2.25011	Yes	
441-076-1045	Perform Headout Operation	SY2.25303	Yes	
441-076-1046	Perform Cal Fire Procedures	SY2.23602	F	
441-076-1047	Acquire Targets in Jammed Sector	SY2.26304	Yes	

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
441-076-1048	Acquire Targets with Misc Targets on Display	SY2.26304	Yes	
441-076-1049	Prepare System for NBC Attack	SY2.25402	F	
441-076-1050	Acquire Targets in an ECM Environment	SY2.26304	Yes	
441-076-1051	React to NBC Attack	SY2.25402	F	
441-076-1053	Respond to ARM Attack	SY2.26304	Yes	
441-076-1055	Perform Engagement Sequence with Radar Inop	SY2.25204	Yes	
441-076-1056	Perform Engagement Sequence with Laser Inop	SY2.25204	Yes	
441-076-1057	Perform Engagement Sequence with Display Inop	SY2.25204	Yes	
441-076-1058	Perform Engagement Sequence with Optics Inop	SY2.25204	Yes	
441-076-1059	Manually Fire Guns	SY2.23806	Yes	
441-076-1060	Operate PPU Fire Extinguisher System	SY2.23003	F	
441-076-1063	Evacuate the Vehicle	SY2.23003	Yes	
441-076-1064	Perform Hangfire Procedure	SY2.23806	Yes	
441-076-1065	Perform Misfire Procedure	SY2.23806	Yes	
441-076-1066	Perform Manual Round Removal	SY2.23806	Yes	
441-076-1067	Remove Stuck Cartridge Case from Chamber	SY2.23806	F	
441-076-1068	Perform One-Man Operations (Squad Leader's Position)	SY2.25303	Yes	
441-076-1069	Perform One-Man Operations (Gunner's Position)	SY2.25303	Yes	

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
441-076-1073	Perform System Before Operations PMCS	SY2.22105	Yes	
441-076-1074	Perform Before Firing Gun Service	SY2.23905	Yes	
441-076-1075	Perform System During Operations PMCS	SY2.22404	Yes	
441-076-1076	Perform System After Operations PMCS	SY2.22404	Yes	
441-076-1077	Perform After Firing Gun Service	SY2.23905	Yes	
441-076-1078	Perform System Weekly PMCS	SY2.22505	Yes	
441-076-1079	Perform Weekly Gun Service	SY2.23905	Yes	
441-076-1080	Perform System Monthly PMCS	SY2.22505	Yes	
441-076-1081	Perform Monthly Gun Service	SY2.23905	Yes	
441-076-1082	Perform Quarterly Gun Service	SY2.23905	Yes	
441-076-1083	Disassemble Breech Block	SY2.24016	Yes	
441-076-1084	Assemble Breech Block	SY2.24016	Yes	
441-076-1085	R/R Closing Spring	SY2-24016	Yes	
441-076-1086	R/R Striker Spring	SY2.24016	Yes	
441-076-1087	R/R Extractors and Spindle	SY2.24016	Yes	
441-076-1088	R/R Auto Loader Rammer Spring	SY2.24016	Yes	
441-076-1089	Service Flash Hiders	SY2.23905	F	
441-076-1090	Perform Operator Corrective Action on Display	SY2.22709	Yes	
441-076-1091	Perform Operator Corrective Action on Periscope	SY2.22709	Yes	
441-076-1092	Perform Operator Corrective Action on Gunsight	SY2.22709	Yes	
441-076-1093	Perform Operator Corrective Action on Radar	SY2.22709	Yes	
441-076-1094	Perform Operator Corrective Action on Laser	SY2.22709	Yes	

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
441-076-1095	Perform Operator Corrective Action on Hydraulic System	SY2.22709	Yes	
441-076-1096	Perform Operator Corrective Action on Hydraulic System	SY2.22709	Yes	
441-076-1097	Perform Operator Corrective Action on Feed	SY2.22709	Yes	
441-076-1098	Perform Operator Corrective Action Gun	SY2.22607	Yes	
441-076-1099	Respond to Subsystem Status Lights	SY2.22607	Yes	
441-076-1100	Respond to SST Messages	SY2.22607	Yes	
441-076-1101	Perform Fault Isolate Tests	SY2.24216	Yes	
441-076-1102	Operate Turret - Gun Drive in Maintenance Mode	SY2.24216	Yes	
441-076-1103	Utilize Maintenance Data in Maintenance Mode	SY2.24216	Yes	
441-076-1104	Clear Gun Error Messages	SY2.21906	Yes	
441-076-1105	Perform Power Shutdown (Vehicle)	SY2.21906	Yes	
441-076-1106	Perform Power Shutdown (PPU)	SY2.21906	Yes	
441-076-1107	Perform Power Shutdown (Silent Mode)	SY2.25502	Yes	
441-076-1108	Operate the Personnel Heater	SY2.22316	F	
441-076-1109	Drive the M247	SY2.26001	Yes	
441-076-1114	Perform Vehicle Towing Procedures			
441-076-1120	Prepare System for Refueling	SY2.26001	F	
441-076-1122	R/R Squad Leader's and Gunner's Panel Lamps	SY2.22709	Yes	
441-076-1130	R/R Switch Knobs (Squad Leader's and Gunner's Panels)	SY2.22709	Yes	
441-076-1131	R/R Available/On Line Switch Lamps	SY2.22709	Yes	

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
441-076-1133	Perform Engagement Sequence with Optics Only	SY2.25204	Yes	
441-076-1134	Camouflage the System	SY2.26001	F	
441-076-1135	Safe the Guns	SY2.26001	Yes	
441-076-1136	Prepare the System for Fording Operations	SY2.26001	F	
441-076-1137	Perform Fording Operations	SY2.26001	F	
441-076-1141	Perform Battle Quick Start Procedure	SY2.21906	Yes	
441-076-1147	Operate Troop Proficiency Trainer	SY2.25805	NC	
441-076-1148	Visually Identify Threat Vehicles	SY2.20224	Yes	
441-076-1149	Manually Load Guns	SY2.23806	Yes	
441-076-1151	Clear Jam Using Maintenance Mode	SY2.24216	Yes	
441-076-1157	Perform Before Operations PMCS on M548 Carrier	SY2.20304	NC	
441-076-1158	Perform During Operations PMCS on M548 Carrier	SY2.20503	NC	
441-076-1159	Perform After Operations PMCS on M548 Carrier	SY2.20604	NC	
441-076-1160	Perform Weekly PMCS on M548 Carrier	SY2.20704	NC	
441-076-1163	Operate on M548 Carrier	SY2.20404	NC	
441-076-1170	Key the IFF	SY2.23503	Yes	
441-076-1175	Respond to Go/No Go Lights	SY2.22607	Yes	
441-076-1194	Manually Enter Weather Data	SY2.25204	Yes	

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

2. OTHER TASKS AND SUBJECTS TAUGHT IN RESIDENT TRAINING:

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
	Physical Fitness Training	SY5.80804	F	
441-076-1177	Perform Power Start Up (External)	SY2.21906	F	
441-076-1178	Perform Power Shutdown (External)	SY2.21906	F	
441-076-1180	R/R Driver's M27 Periscope	SY2.23403	F	
441-076-1190	Install/Remove Equipment Covers	SY2.23503	F	
441-076-1191	Stow OVE	SY2.22004	F	
441-076-1192	Key the T-Sec KYK-18	SY2.26608	F	
441-076-1193	Charge the Interrogator Batteries	SY2.26608	NC	
	Overview of Curriculum and Training Resources	SY2.20905	F	
	Subsystem Descriptions	SY2.21003	F	
	SGT York Safety	SY2.21104	Yes	
	Crew Compartment Controls and Indicators	SY2.21208	Yes	
	Control Grip Switchology	SY2.21305	Yes	
	Operate and Non-Operate Modes	SY2.21401	F	
	Built-in Test	SY2.21502	F	
	SGT York Radar	SY2.26232	Yes	
		SY2.26304	Yes	
		SY2.25204	Yes	
	Driver Compartment Controls and Indicator	SY2.22204	Yes	
	System Integration I	SY2.22801	F	
	System Integration II	SY2.22902	F	

Appendix B (Cont.)

TRAINING TASKS TAUGHT IN FOE 16L TRANSITION COURSE

Task Number	Title	POI File Number	Trained to Job Performance Standard Peacetime*	Remarks
	Respond to Emergencies	SY2.23003	Yes	
	40mm Gun Functional Description and Ammunition	SY2.23704	Yes	
	Feed System Functional Description	SY2.24103	Yes	
	The Display	SY2.24403	Yes	
	Marginal and Recall Data	SY2.24504	Yes	
	The Engagement Sequence	SY2.24602	Yes	
	Combat Scenarios	SY2.25116	Yes	
	Engage Targets (Aerial and Ground)	SY2.26232	Yes	

Appendix C

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W I C-1	OPERATE PURGING KIT	SDE	F
24W I C-1	OPERATE BOOM HOIST	SERAN	Q
24W II A-3	LOCATE MECHANICAL FAILURE WITHIN GUN SUBSYSTEM	GMA	F
24W II B 1	R/R LEFT GUN FIRE SENSOR	GMAKFFC6	Q
24W II B 1	REPAIR L/R BREECHBLOCK BY R/R OUTER CRANK	GMAKFFJAG/GMAKGFJAG	Q
24W II B 1	REPAIR L/R BREECHBLOCK BY R/R CRANKSHAFT	GMAKFFJAG/GMAKGFJAG	Q
24W II B 1	REPAIR L/R BREECHBLOCK BY R/R R/H OPERATING CRANK	GMAKFFJAG/GMAKGFJAG	Q
24W II B 1	REPAIR L/R BREECHBLOCK BY R/R L/H OPERATING CRANK	GMAKFFJAG/GMAKGFJAG	Q
24W II B 1	R/R RIGHT GUN FIRE SENSOR	GMAKGFC6	Q
24W II B-1	R/R LEFT BARREL	GMAKFFA	Q
24W II B-1	REPAIR L/R GUN BARREL BY R/R RECUPERATOR SPRING	GMAKFFA/GMAKGFA	NC
24W II B-1	R/R LEFT FLAME GUARD	GMAKFFAH	Q
24W II B-1	R/R LEFT AUTOMATIC LOADER	GMAKFFC	F
24W II B-1	REPAIR L/R AUTOLOADER BY R/R RD CATCH LEVER SPRINGS	GMAKFFC/GFC	Q
24W II B-1	REPAIR L/H AUTOLOADER BY R/R LEFT ROUND #2 SENSOR	GMAKFFC5	Q
24W II B-1	REPAIR L/H AUTOLOADER BY R/R ACCESS RD POS. 2 DOOR	GMAKFFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R GUIDE ACCESS DOOR SPRING	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R FIRING HANDLE	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R FIRING HANDLE LINKAGE ROD	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R FIRING HANDLE LINKAGE LEVER	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R FIRE ACTUATOR EXTENSION BAR	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R SHIFT TONGUE RELEASE LOCK	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R SYNCHRONIZATION DISCONNECT DIAL	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R SYNCHRONIZATION DISCONNECT DIAL LOCK	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R MANUAL COCKING SUPPORT BRACKET	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R MODE SELECT LINKAGE SHAFT	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R L/R MODE SELECT ACTUATOR LINKAGE ARMS	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R TUBE FRAME ASSEMBLY	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R ROUND POSITION #1 SENSOR BRACKET	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R COCKING ARM BRACKET GREASE FITTING	GMAKFFC5/GFC5	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R MANUAL FIRING LINKAGE ROD SPRING	GMAKFFC5/GFC5	Q
24W II B-1	R/R SENSOR #3	GMAKFFC6	Q
24W II B-1	R/R ROUND POSITION #1 SENSOR	GMAKFFC6	Q
24W II B-1	R/R ROUND POSITION #3 SENSOR	GMAKFFC6	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R SHIFT TONGUE PIVOT GREASE FITTING	GMAKFFC6/GFC6	Q
24W II B-1	REPAIR L/R AUTOLOADER BY R/R CATCH GEAR SHAFT GREASE FITTING	GMAKFFC6/GFC6	Q
24W II B-1	REPAIR L/H AUTOLOADER BY R/R LEFT RAM COCKED SENSOR	GMAKFFC7	Q
24W II B-1	REPAIR L/H AUTOLOADER BY R/R LEFT RAM NOT COCKED SENSOR	GMAKFFC7	Q
24W II B-1	R/R LEFT MODE SELECT ACTUATOR	GMAKFFCAR	Q
24W II B-1	R/R LEFT FIRING ACTUATOR	GMAKFFCAV	Q

NOTES

Q - QUALIFIED

F - FAMILIARIZED

NC - NOT COVERED

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W II B-1	R/R LEFT FEED HOPPER	GHAKFFF	F
24W II B-1	REPAIR LEFT FEED HOPPER BY R/R LEFT ROUND #4 SENSOR	GHAKFFFS	Q
24W II B-1	REPAIR R/H FEED HOPPER BY R/R RIGHT ROUND #4 SENSOR	GHAKFFFS	Q
24W II B-1	REPAIR L/R FEED HOPPER BY R/R GUIDE ASSY	GHAKFFFS/GFF	Q
24W II B-1	REPAIR L/R FEED HOPPER BY R/R FIXED PAWL HOLDER	GHAKFFFS/GFF	Q
24W II B-1	REPAIR L/R FEED HOPPER BY R/R INITIAL LOAD ACTUATOR SUPPORT SHAFT	GHAKFFFS/GFFS	Q
24W II B-1	REPAIR L/R FEED HOPPER BY R/R RIGHT ROUND GUIDE	GHAKFFFS/GFFS	Q
24W II B-1	REPAIR L/R FEED HOPPER BY R/R LEFT ROUND GUIDE	GHAKFFFS/GFFS	Q
24W II B-1	REPAIR L/R FEED HOPPER BY R/R INITIAL LOAD ACTUATOR ARM	GHAKFFFS/GFFS	Q
24W II B-1	R/R LEFT INITIAL LOAD SENSOR	GHAKFFF6	Q
24W II B-1	R/R LEFT INITIAL LOAD ACTUATOR	GHAKFFFAN	Q
24W II B-1	R/R LEFT BREECHBLOCK LOW SENSOR	GHAKFFJ	Q
24W II B-1	R/R LEFT BREECHBLOCK HIGH	GHAKFFJ	Q
24W II B-1	R/R LEFT 20mm FROM BAT SENSOR	GHAKFFJ	Q
24W II B-1	REPAIR L/R BREECH CASING BY R/R SIDE COVER ASSY	GHAKFFJ/GFJ	Q
24W II B-1	TEST L/R BREECH MECHANISM OPERATION	GHAKFFJAG	F
24W II B-1	R/R LEFT BREECH RING	GHAKFFJAGB	F
24W II B-1	REPAIR L/R BREECHBLOCK BY R/R OUTER CRANK ROLLER	GHAKFFJAGF/GFJAGF	Q
24W II B-1	REPAIR LEFT SPRING CASE BY R/R CLOSING SPRING	GHAKFFJAGK	F
24W II B-1	REPAIR L/R OPERATING SPRING CASE BY R/R OUTER CASE	GHAKFFJAGK/GHAKGFJAGF	Q
24W II B-1	REPAIR L/R OPERATING SPRING CASE BY R/R INNER CASE	GHAKFFJAGK/GHAKGFJAGF	F
24W II B-1	R/R LEFT GUN CAM PATH PLATES	GHAKFFJAL	F
24W II B-1	R/R LEFT RECOIL BUFFER	GHAKFFJAQ	Q
24W II B-1	R/R RIGHT BARREL	GHAKGFA	Q
24W II B-1	REPAIR R/R GUN BARREL BY R/R RECUPERATOR SPRING	GHAKGFA	NC
24W II B-1	R/R RIGHT AUTOMATIC LOADER	GHAKGFC	F
24W II B-1	REPAIR R/H AUTOLOADER BY R/R ACCESS RD POS. 2 DOOR	GHAKGFCS	Q
24W II B-1	R/R SENSOR #4	GHAKGFC6	Q
24W II B-1	R/R SENSOR #3	GHAKGFC6	Q
24W II B-1	R/R SENSOR #4	GHAKGFC6	Q
24W II B-1	R/R ROUND POSITION #1 SENSOR	GHAKGFC6	Q
24W II B-1	R/R ROUND POSITION #3 SENSOR	GHAKGFC6	Q
24W II B-1	REPAIR R/H AUTOLOADER BY R/R RIGHT RAM COCKED SENSOR	GHAKGFC7	Q
24W II B-1	REPAIR R/H AUTOLOADER BY R/R RIGHT RAM <u>NOT</u> COCKED SENSOR	GHAKGFC7	Q
24W II B-1	R/R RIGHT MODE SELECT ACTUATOR	GHAKGFCAR	Q
24W II B-1	R/R RIGHT FIRE ACTUATOR	GHAKGFCAV	Q
24W II B-1	R/R RIGHT FEED HOPPER	GHAKGFF	F
24W II B-1	R/R RIGHT INITIAL LOAD SENSOR	GHAKGFFS	Q
24W II B-1	R/R RIGHT BREECHBLOCK LOW SENSOR	GHAKGFG	Q
24W II B-1	R/R RIGHT BREECHBLOCK HIGH	GHAKGFG	Q

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W II B-1	R/R RIGHT 20mm FROM BAT SENSOR	GMAKGFG	Q
24W II B-1	R/R RIGHT BREECH RING	GMAKGFJAGB	F
24W II B-1	REPAIR RIGHT SPRING CASE BY R/R CLOSING SPRING	GMAKGFJAGE	F
24W II B-1	R/R RIGHT GUN CAM PATH PLATES	GMAKGFJAL	F
24W II B-1	R/R RIGHT RECOIL BUFFER	GMAKGFJAQ	Q
24W II B-2	R/R RESOLVER/TACH	GMABC	F
24W II B-2	REPAIR ELEV MASS BY R/R SUPPORT FEED FAN	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R GUN MANIFOLD	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R ROLLING LOOP PRESS LINE BKT	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R ROLLING LOOP RTN LINE BKT	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R INITIAL FEED PRESS LINE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R INITIAL FEED RTN LINE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R LWR MAN. PRESS. LINE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R LWR MAN. RTN LINE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R FIRE ACTUATOR RTN TUBE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R CHARGE ACTUATOR PRESS TUBE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R L/R UPPER MAN. RTN HOSES	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R L/R UPPER MAN. PRESS. HOSES	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R MODE SELECT RTN TUBE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R MODE SELECT PRESS TUBE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R FIRING ACTUATOR PRESSURE TUBE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R MANIFOLD "TEE" TUBE	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R ROLLING LOOP BKT	GMAK	F
24W II B-2	REPAIR ELEV MASS BY R/R FEED MOTOR DRAIN HOSE	GMAKS	F
24W II B-2	REPAIR ELEV MASS BY R/R FEED MOTOR RTN HOSE	GMAKS	F
24W II B-2	REPAIR ELEV MASS BY R/R FEED MOTOR PRESS. HOSE	GMAKS	F
24W II B-2	R/R LOWER ELEVATION BUFFER SHOCK	GMAKAF	F
24W II B-2	R/R L/R LOWER GUN MANIFOLD	GMAKFFCJJ/GFCAF	F
24W II B-2	R/R L/R UPPER GUN MANIFOLD	GMAKFFJAT/GFJAT	F
24W II B-2	R/R GUN FEED CONTROL UNIT	GMAKJ	Q
24W II B-2	R/R UPPER ELEVATION BUFFER SHOCK	GMMBB	NC
24W II B-2	R/R AFT EJECTION CHUTE ASSY	GMAAXAE	F
24W II B-2	REPAIR AFT EJECTION CHUTE BY R/R L/H AFT EJECTION CHUTE	GMAAXAE	F
24W II B-2	REPAIR AFT EJECTION CHUTE BY R/R R/H AFT EJECTION CHUTE	GMAAXAE	F
24W II B-2	R/R CENTER EJECTION CHUTE	GMAAXAJ	F
24W II B-2	REPAIR CENTER EJECTION CHUTE BY R/R L/H EJECTION CHUTE	GMAAXAJ	F
24W II B-2	REPAIR CENTER EJECTION CHUTE BY R/R R/H EJECTION CHUTE	GMAAXAJ	F
24W II B-2	REPAIR CENTER EJECTION CHUTE BY R/R CAM HANDLE	GMAAXAJ	F
24W II B-2	R/R FORWARD EJECTION CHUTE	GMAAXAN	F
24W II B-2	REPAIR FORWARD EJECTION CHUTE BY R/R L/H FORWARD EJECTION CHUTE	GMAAXAN	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W II B-2	REPAIR FORWARD EJECTION CHUTE BY R/R R/H FORWARD EJECTION CHUTE	GMAAKAN	F
24W II B-2	R/R LEFT GUN CHUTE	GMAKAP	F
24W II B-2	REPAIR LEFT GUN CHUTE BY R/R SPRING	GMAKAP	F
24W II B-2	R/R RIGHT GUN CHUTE	GMAKAQ	F
24W II B-2	REPAIR RIGHT GUN CHUTE BY R/R SPRING	GMAKAQ	F
24W II B-2	REPAIR MOUNT ASSY BY R/R L/H COUPLER PLATE	GMM	NC
24W II B-2	REPAIR MOUNT ASSY BY R/R R/H COUPLER PLATE	GMM	NC
24W II C-1	PERFORM SCHEDULED SERVICE ON THE GUN SUBSYSTEM	GMA	Q
24W II C-1	PERFORM SERVICE ON L/R RECOIL BUFFERS	GMAKFPJAQ/GFJAQ	F
24W III A-3	CLEAR FEED SUBSYSTEM JAMS	GMA	F
24W III A-3	LOCATE MECHANICAL FAILURE WITHIN FEED SUBSYSTEM	GMA	F
24W III B-1	REPAIR L/R ARTICULATING ARM BY R/R IDLER SHAFT	GMALBEE/CEE	F
24W III B-1	REPAIR L/R ARTICULATING ARM BY R/R CHAIN ADJUSTER PARTS	GMALBEE/CEE	F
24W III B-1	REPAIR L/R ARTICULATING ARM BY R/R UPPER HANDOFF GEAR	GMALBEE/CEE	F
24W III B-1	REPAIR L/R ARTICULATING ARM BY R/R MACHINE ARM/SHAFT	GMALBEE/CEE	F
24W III B-1	R/R LEFT UPPER MAG #42 SENSOR	GMALBN	Q
24W III B-1	R/R LEFT UPPER MAG #43 SENSOR	GMALBN	Q
24W III B-1	ADJUST L/R UPPER MAGAZINE CHAIN TENSION	GMALBN/CE	F
24W III B-1	CHECK L/R UPPER MAGAZINE CHAIN TENSION	GMALBN/CE	F
24W III B-1	R/R RIGHT UPPER MAG #42 SENSOR	GMALCE	Q
24W III B-1	R/R RIGHT UPPER MAG #43 SENSOR	GMALCE	Q
24W III B-1/6	R/R UPPER LEFT MAGAZINE	GMALBN	Q
24W III B-1/6	REPAIR UPPER L/R MAGAZINES BY R/R FWD ACCESS COVERS	GMALBN/GMALCE	Q
24W III B-1/6	R/R UPPER RIGHT MAGAZINE	GMALCE	F
24W III B-2	R/R L/R ELEVATOR CONVEYOR ELEMENT ASSY	GMALVEE/LWEE	Q
24W III B-2/6	REPAIR LEFT TRUNNION BY R/R LEFT OUTBOARD TRUNNION HUB	GMALN	F
24W III B-2/6	R/R LEFT TRUNNION SHAFT ASSY	GMALNE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R OUTBOARD GEAR	GMALNE/RE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R THE RIM SPROCKET	GMALNE/EE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R THE SPACER TUBES (2 EA)	GMALNE/RE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R INBOARD GEAR	GMALNE/RE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R THRUST WASHERS (2 EA)	GMALNE/RE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R SPROCKET NECK	GMALNE/RE	F
24W III B-2/6	REPAIR L/R SHAFT ASSY BY R/R THE SHAFT	GMALNE/RE	F
24W III B-2/6	REPAIR L/R TRUNNION SHAFT BY R/R RETAINING RING	GMALNE/RE	F
24W III B-2/6	REPAIR L/R TRUNNION SHAFT BY R/R ADJUSTABLE SPACERS	GMALNE/RE	F
24W III B-2/6	R/R LEFT INBOARD TRUNNION HUB	GMALNJ	F
24W III B-2/6	REPAIR L/R INBOARD TRUNNION HUB BY R/R BEARING	GMALNJ/RJ	F
24W III B-2/6	R/R LEFT TRUNNION PLATE SUPPORT	GMALNL	F
24W III B-2/6	R/R LEFT TRUNNION ROUND GUIDE	GMALNQ	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W III B-2/6	REPAIR L/R ROUND GUIDE ASSY BY R/R THE SUPPORT	GHALNQ/RQ	F
24W III B-2/6	REPAIR L/R ROUND GUIDE ASSY BY R/R GUIDE-RIM	GHALNQ/RQ	F
24W III B-2/6	REPAIR L/R ROUND GUIDE ASSY BY R/R GUIDE-NECK	GHALNQ/RQ	F
24W III B-2/6	REPAIR RIGHT TRUNNION BY R/R RIGHT OUTBOARD TRUNNION HUB	GHALR	F
24W III B-2/6	R/R RIGHT TRUNNION SHAFT	GHALRE	F
24W III B-2/6	R/R RIGHT INBOARD TRUNNION HUB	GHALRJ	F
24W III B-2/6	R/R RIGHT TRUNNION PLATE SUPPORT	GHALRL	F
24W III B-2/6	R/R RIGHT TRUNNION ROUND GUIDE	GHALRQ	F
24W III B-4	R/R LEFT FAN CONVEYOR LOWER ROUND #7 SENSOR	GHALEE	Q
24W III B-4	R/R LEFT FAN CONVEYOR RD POSITION #5 SENSOR	GHALEE	Q
24W III B-4	REPAIR L/R FAN CONVEYOR BY R/R CLOSURE	GHALEE/JE	F
24W III B-4	REPAIR L/R FAN CONVEYOR BY R/R INBOARD NECKGUIDE	GHALEE/JE	F
24W III B-4	REPAIR L/R FAN CONVEYOR BY R/R LOWER FLAG ASSY - RD 7	GHALEE/JE	F
24W III B-4	REPAIR L/R FAN CONVEYOR BY R/R UPPER FLAG ASSY - RD 7	GHALEE/JE	F
24W III B-4	ADJUST L/R FAN CONVEYOR UPPER CONVEYOR TRACK	GHALEE/JE	F
24W III B-4	ADJUST L/R FAN CONVEYOR LOWER CONVEYOR TRACK	GHALEE/JE	F
24W III B-4	REPAIR L/R FAN CONVEYOR BY R/R PAWL INSERT	GHALEE/JE	F
24W III B-4	R/R LEFT FAN CONVEYOR UPPER ROUND #7 SENSOR	GHALEES	Q
24W III B-4	R/R L/R FEED RESOLVER ASSY	GHALEE6/JEAE	Q
24W III B-4	R/R L/R FAN CONVEYOR UPPER BRAKE ASSYS	GHALEEAN/JEAN	F
24W III B-4	R/R L/R FAN CONVEYOR LOWER BRAKE ASSY	GHALEEAN/JEAN	F
24W III B-4	R/R LEFT FAN CONVEYOR CONSENT SWITCH	GHALEEBE	Q
24W III B-4	R/R L/R LOWER CLUTCH DIODE ASSY	GHALEEFR/JEFR	F
24W III B-4	R/R L/R UPPER CLUTCH DIODE ASSY	GHALEEFR/JEFR	F
24W III B-4	R/R L/R BRAKE DIODE ASSY	GHALEEFV/JEFV	Q
24W III B-4	REPAIR L/R FAN CONVEYOR X-FER COVER BY R/R NECKGUIDE	GHALEEFZL/JEFZL	F
24W III B-4	R/R LEFT LOADING GATE	GHALEER	Q
24W III B-4	R/R L/R LOWER ROUND STRIPPER	GHALEEWE/JEWE	F
24W III B-4	R/R L/R UPPER ROUND STRIPPER	GHALEEWJ/JEWJ	F
24W III B-4	R/R L/R TACHOMETER ASSY	GHALES/J	F
24W III B-4	R/R LEFT FEED MOTOR	GHALEX	F
24W III B-4	R/R RIGHT FAN CONVEYOR PROX SENSOR #35	GHALJE	F
24W III B-4	R/R RIGHT FAN CONVEYOR UPPER ROUND #7 SENSOR	GHALJE	F
24W III B-4	R/R RIGHT FAN CONVEYOR LOWER ROUND #7 SENSOR	GHALJES	F
24W III B-4	R/R RIGHT LOADING GATE	GHALJES	F
24W III B-4	R/R RIGHT FAN CONVEYOR CONSENT SWITCH	GHALJEBE	F
24W III B-4	R/R RIGHT FEED MOTOR	GHALJX	F
24W III B-5	R/R L/R LOWER MAGAZINE PROX SENSOR #40	GHAME/J	F
24W III B-5	R/R L/R LOWER MAGAZINE PROX SENSOR #40 ACTUATOR	GHAMEB/JZ	F
24W III B-5	REPAIR L/R LWR MAGAZINE SPROCKET BOX BY R/R TRK CONVEYOR END TURN	GHAMEQ/JQ	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W III B-5	REPAIR L/R LWR MAGAZINE SPROCKET BOX BY R/R CONVEYOR SPKT	GMAMEQ/JQ	F
24W III B-5	REPAIR L/R LWR MAGAZINE SPROCKET BOX BY R/R TRANSFER GEAR	GMAMEQ/JQ	F
24W III B-5	REPAIR L/R LWR MAGAZINE SPROCKET BOX BY R/R IDLER GEAR	GMAMEQ/JQ	F
24W III B-5	REPAIR L/R LWR MAGAZINE SPROCKET BOX BY R/R DRIVE GEAR	GMAMEQ/JQ	F
24W III B-5	REPAIR L/R LWR MAGAZINE SPROCKET BOX BY R/R SPROCKET SHAFT	GMAMEQ/JQ	F
24W III B-5	R/R L/R LOWER MAGAZINE CONVEYOR ELEMENT ASSY	GMAMER/JR	F
24W III B-5	R/R L/R LOWER MAGAZINE PROX SENSOR #41	GMAMEX/JX	F
24W III B-5	R/R L/R LOWER MAGAZINE PROX SENSOR #41 ACTUATOR	GMAMEY/JW	F
24W III B-6	REPAIR FEED SUBSYSTEM FAULTS (ON VEHICLE)	GMA F	F
24W III B-6	R/R LEFT FAN CONVEYOR	GMALEEJE	Q
24W III B-6	R/R RIGHT FAN CONVEYOR	GMALJE	E
24W III B-6	R/R LEFT ELEVATOR	GMALVE	Q
24W III B-6	R/R RIGHT ELEVATOR	GMALWE	F
24W III B-6/1	R/R UPPER LEFT MAGAZINE	GMALBN	Q
24W III B-6/1	REPAIR UPPER L/R MAGAZINES BY R/R FWD ACCESS COVERS	GMALBN/GMALCE	Q
24W III B-6/1	R/R UPPER RIGHT MAGAZINE	GMALCE	F
24W III B-6/2	REPAIR LEFT TRUNNION BY R/R LEFT OUTBOARD TRUNNION HUB	GMALN	F
24W III B-6/2	R/R LEFT TRUNNION SHAFT ASSY	GMALNE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R OUTBOARD GEAR	GMALNE/RE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R THE RIM SPROCKET	GMALNE/RE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R THE SPACER TUBES (2 EA)	GMALNE/RE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R INBOARD GEAR	GMALNE/RE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R THRUST WASHERS (2 EA)	GMALNE/RE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R SPROCKET NECK	GMALNE/RE	F
24W III B-6/2	REPAIR L/R SHAFT ASSY BY R/R THE SHAFT	GMALNE/RE	F
24W III B-6/2	REPAIR L/R TRUNNION SHAFT BY R/R RETAINING RING	GMALNE/RE	F
24W III B-6/2	REPAIR L/R TRUNNION SHAFT BY R/R ADJUSTABLE SPACERS	GMALNE/RE	F
24W III B-6/2	R/R LEFT INBOARD TRUNNION HUB	GMALNJ F	F
24W III B-6/2	REPAIR L/R INBOARD TRUNNION HUB BY R/R BEARING	GMALNJ/RJ	F
24W III B-6/2	R/R LEFT TRUNNION PLATE SUPPORT	GMALNL	F
24W III B-6/2	R/R LEFT TRUNNION ROUND GUIDE	GMALNQ	F
24W III B-6/2	REPAIR L/R ROUND GUIDE ASSY BY R/R THE SUPPORT	GMALNQ/RQ	F
24W III B-6/2	REPAIR L/R ROUND GUIDE ASSY BY R/R GUIDE-RIM	GMALNQ/EQ	F
24W III B-6/2	REPAIR L/R ROUND GUIDE ASSY BY R/R GUIDE-NECK	GMALNQ/RQ	F
24W III B-6/2	REPAIR RIGHT TRUNNION BY R/R RIGHT OUTBOARD TRUNNION HUB	GMALR	F
24W III B-6/2	R/R RIGHT TRUNNION SHAFT	GMALRE	F
24W III B-6/2	R/R RIGHT INBOARD TRUNNION HUB	GMALRJ	F
24W III B-6/2	R/R RIGHT TRUNNION PLATE SUPPORT	GMALRL	F
24W III B-6/2	R/R RIGHT TRUNNION ROUND GUIDE	GMALRQ	F
24W III C-1	PERFORM SCHEDULED SERVICE ON THE FEED SUBSYSTEM	GMA	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W IV B-1	R/R TURBINE CONTROL UNIT	GMMAJ	F
24W IV B-1	R/R PRIMARY POWER UNIT	GMME	Q
24W IV B-1	REPAIR PPU BY R/R PHP CASE DRAIN HOSE #1279805	GMME	Q
24W IV B-1	REPAIR PPU BY R/R PHP CASE DRAIN SWIVEL FITTING (R-3)	GMME	F
24W IV B-1	REPAIR PPU BY R/R PHP SUCTION SWIVEL FITTING (R-2)	GMME	F
24W IV B-1	REPAIR PPU BY R/R PHP PRESSURE SWIVEL FITTING (P-2)	GMME	F
24W IV B-1	REPAIR PPU BY R/R PHP SUCTION HOSE #12603304	GMME	F
24W IV B-1	REPAIR PPU BY R/R PHP PRESSURE HOSE COUPLING (QD)	GMME	F
24W IV B-1	REPAIR PPU BY R/R PHP PRESSURE HOSE #12603305	GMME	F
24W IV B-1	REPAIR PPU BY R/R PHP SUCTION HOSE COUPLING (QD)	GMME	F
24W IV B-1	REPAIR PPU BY R/R PPU FUEL SUPPLY HOSE COUPLING (QD)	GMME	F
24W IV B-1	REPAIR PPU BY R/R COUPLING HALF HOSE #12603305	GMME	F
24W IV B-1	PERFORM SCHEDULED SERVICE ON THE TURBINE	GMMEC	F
24W IV B-1	REPAIR PPU BY R/R FIRE DETECTOR (450 DEGREE)	GMMEE	Q
24W IV B-1	REPAIR PPU BY R/R FIRE DETECTOR (600 DEGREE)	GMMEE	Q
24W IV B-1	R/R (PRIMARY POWER UNIT) FIRE EXTINGUISHER	GMMEEJ	Q
24W IV B-1	TEST EXTERNAL PPU FIRE EXTINGUISHER SWITCH	GMMEV	F
24W IV B-1	REPAIR REAR DECK BY R/R HOSE	GMMTE	F
24W IV B-1	REPAIR REAR DECK BY R/R GASKET	GMMTE	F
24W IV B-1	REPAIR REAR DECK BY R/R OUTLET DUCT SEAL	GMMTE	F
24W IV B-1	REPAIR REAR DECK BY R/R GASKET	GMMTE	F
24W IV B-1	REPAIR REAR DECK BY R/R INERTIAL AIR CLEANER	GMMTE	Q
24W IV B-1	REPAIR REAR DECK BY R/R BARRIER FILTER	GMMTE	Q
24W IV B-1	R/R CENTRIFUGAL FAN	GMMTECF	Q
24W IV B-1	R/R SCAVENGER FAN	GMMTECK	Q
24W IV B-2	R/R AUXILIARY ALTERNATOR CONTROL UNIT	GMMAF	Q
24W IV B-2	R/R PRIMARY ALTERNATOR CONTROL UNIT	GMMAC	Q
24W IV B-2	R/R STARTER/GENERATOR CONTROL UNIT	GMMAH	F
24W IV B-2	R/R PRIMARY ALTERNATOR	GMMEN	Q
24W IV B-2	R/R PPU STARTER DC GENERATOR	GMMEV	Q
24W IV B-3	R/R POWER CONTROL UNIT (PCU)	GMMAE	F
24W IV B-3	R/R AUXILIARY ALTERNATOR	GMMAEF	Q
24W IV B-3	R/R POWER DISTRIBUTION UNIT (PDU)	GMMBG	Q
24W IV B-3	R/R LOW VOLTAGE POWER SUPPLY (LVPS)	GMMBH	Q
24W IV B-4	REPAIR CABLE ASSYS BY R/R CONNECTOR	G	NC
24W IV B-4	REPAIR CABLE ASSYS BY R/R CONTACTS	G	NC
24W IV B-4	REPAIR CABLE ASSYS BY R/R TERMINAL LUGS	G	NC
24W IV B-4	REPAIR CABLE ASSYS BY R/R BOOTS	G	NC
24W IV B-4	REPAIR CABLE ASSYS BY R/R CABLE JACKETS	G	NC
24W IV B-4	REPAIR CABLE ASSYS BY R/R BACKSHELL ADAPTER	G	NC

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W IV B-4	R/R CABLE ASSY W117	GMMBFAK	F
24W IV B-4	R/R CABLE ASSY W120	GMMBFAL	F
24W IV B-4	R/R CABLE ASSY W121	GMMBFAM	F
24W IV B-4	R/R CABLE ASSY W122	GMMBFAN	F
24W IV B-4	R/R CABLE ASSY W123	GMMBFAP	F
24W IV B-4	R/R CABLE ASSY W125	GMMBFAR	F
24W IV B-4	R/R CABLE ASSY W126	GMMBFAS	F
24W IV B-4	R/R CABLE ASSY W127	GMMBFAT	F
24W IV B-4	R/R CABLE ASSY W128	GMMBFAU	F
24W IV B-4	R/R CABLE ASSY W134	GMMBFAW	F
24W IV B-4	R/R CABLE ASSY W135	GMMBFAX	F
24W IV B-4	R/R CABLE ASSY W136	GMMBFAY	F
24W IV B-4	R/R CABLE ASSY W138	GMMBFAZ	F
24W IV B-4	R/R CABLE ASSY W139	GMMBFBA	F
24W IV B-4	R/R CABLE ASSY W140	GMMBFBB	F
24W IV B-4	R/R CABLE ASSY W141	GMMBFBC	F
24W IV B-4	R/R CABLE ASSY W142	GMMBFBD	F
24W IV B-4	R/R CABLE ASSY W143	GMMBFBE	F
24W IV B-4	R/R CABLE ASSY W144	GMMBFBF	F
24W IV B-4	R/R CABLE ASSY W145	GMMBFBG	F
24W IV B-4	R/R CABLE ASSY W146	GMMBFBH	F
24W IV B-4	R/R CABLE ASSY W147	GMMBFBJ	F
24W IV B-4	R/R CABLE ASSY W148	GMMBFBK	F
24W IV B-4	R/R CABLE ASSY W156	GMMBFBM	F
24W IV B-4	REPAIR CABLE ASSEMBLIES W157-W160	GMMBFBN/P/Q/R	F
24W IV B-4	REPAIR CABLE ASSY W7	GMSCNFJ	F
24W IV B-4	REPAIR CABLE ASSY W53	GMSCNFLL	F
24W IV B-4	REPAIR CABLE ASSY W10	GMSCNFLM	F
24W IV B-4	REPAIR CABLE ASSY W54	GMSCNFLQ	F
24W IV B-4	REPAIR CABLE ASSY W2	GMSCNFLS	F
24W IV B-4	REPAIR CABLE ASSY W50	GMSCNFLV	F
24W IV B-4	REPAIR CABLE ASSY W51	GMSCNFLX	F
24W II A-2	REPAIR FORWARD SEGMENT BY R/R SEAL	GMAKN	F
24W II A-2	REPAIR UPPER MANTLET ACCESS DOOR BY R/R SEAL (1 of 4)	GMAKNECP	F
24W II A-2	REPAIR MOUNT BY R/R TRACK ANTENNA ACCESS COVER SEAL	GMMAP	F
24W II A-2	REPAIR MOUNT BY R/R L/H GUN BAY COVER O/B GASKET	GMMAP	F
24W II A-2	REPAIR LEFT MAINTENANCE HOOD BY R/R SEAL	GMMAPAAG	F
24W II A-2	REPAIR L/R GRENADE COVER ASSY BY R/R GASKET	GMMAPAACE/HE	F
24W II A-2	REPAIR RIGHT MAINTENANCE HOOD BY R/R SEAL	GMMAPAAH	F
24W II A-2	REPAIR SQUAD LEADER'S HATCH BY R/R SEAL	GMMAPADAA	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W IX A-2	REPAIR GUNNER'S HATCH BY R/R SEAL	GHMAPARAA	F
24W IX A-2	REPAIR LOADING HATCH BY R/R LOADING HATCH SEAL	GHMAPAFAA	F
24W IX A-2	REPAIR SEARCH ANTENNA PAD AND PLATE BY R/R PAD	GHMAPAI	
24W IX A-2	REPAIR SEARCH ANTENNA COVER BY R/R GASKET	GHMAPAN	
24W IX A-2	REPAIR SEARCH ANTENNA ACCESS COVER BY R/R GASKET	GHMAPANAA	
24W IX A-2	REPAIR ECU FILTER ACCESS COVER BY R/R GASKET	GHMAPAOAA F	F
24W IX A-2	REPAIR WHIP ANTENNA COVER BY R/R SEAL	GHMAPARAA	NC
24W IX A-2	REPAIR L/R GUN BAY COVER BY R/R GASKETS	GHMAPAT/V	Q
24W IX A-2	REPAIR ECU DOOR BY R/R COVER	GHMAPAX	F
24W IX A-2	REPAIR FIREWALL HATCH BY R/R GASKET	GHMAPBJ	
24W IX A-2	REPAIR FIREWALL HATCH BY R/R SEAL	GHMAPBJ	F
24W IX A-2	REPAIR FIREWALL ASSY ACCESS PANEL BY R/R GASKET	GHMAPCA	F
24W IX A-2	REPAIR L/R FORWARD FIXED MANTLETS BY R/R GASKETS	GHMAPZBAA/B	F
24W IX A-2	REPAIR EXTENSION MANTLET BY R/R GASKETS	GHMAPZBAG	F
24W IX A-2	REPAIR AIR OUTLET ASSY BY R/R SEAL	GHMAQCV	F
24W IX A-2	REPAIR ROTOR ASSY BY R/R TRANSVERSE SEAL	GHMAQETS	NC
24W IX A-2	REPAIR ROTOR ASSY BY R/R HOOP SEAL	GHMAQETW	NC
24W IX A-2	REPAIR ECU BY R/R BULKHEAD SEAL	GHMAV	F
24W IX A-2	REPAIR CONTROL VALVE ASSY BY R/R SEAL	GHMAWEV	NC
24W IX A-2	REPAIR GAS SEAL BARRIER BY R/R SEALS (2)	GHMTJ	F
24W IX A-2	REPAIR GAS SEAL BARRIER BY R/R WRAP SEAL	GHMTJ	F
24W IX B-1	REPAIR CREW SEATS BY R/R MOUNT FRAME	GHMAPAB	F
24W IX B-1	REPAIR CREW SEATS BY R/R HORIZONTAL LOCK PIN	GHMAPAB	F
24W IX B-1	REPAIR CREW SEATS BY R/R VERTICAL LOCK PIN	GHMAPAB	F
24W IX B-1	REPAIR CREW SEATS BY R/R CAM FOLLOWER BEARINGS	GHMAPAB	F
24W IX B-1	REPAIR CREW SEATS BY R/R GUIDE RAIL MOUNT	GHMAPAB	F
24W IX B-1	REPAIR CREW SEATS BY R/R SLIDE	GHMAPAB	F
24W IX B-1	REPAIR CREW SEATS BY R/R SEAT/BACK REST FRAME ASSY	GHMAPAB	F
24W IX B-1	R/R GUNNER'S SEAT ASSY	GHMAPABAE	Q
24W IX B-1	REPAIR CREW SEATS BY R/R BACK RESTS	GHMAPABAEK/JK	F
24W IX B-1	REPAIR CREW SEATS BY R/R RESTRAINT SYSTEM	GHMAPABAEP	Q
24W IX B-1	R/R SQUAD LEADER'S SEAT ASSY	GHMAPABAJ	Q
24W IX B-1	R/R AZIMUTH LOCK	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R TRAVEL SCREW	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R HANDLE	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R SUPPORT BRACKET	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R SUPPORT RING	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R HOUSING	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R COMPRESSION SPRING	GHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R COVER	GHMBEM	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W IV B-4	REPAIR CABLE ASSYS BY R/R BRAID	G	NC
24W IV B-4	REPAIR CABLE ASSY W52	GAPABAU	NC
24W IV B-4	R/R CABLE ASSY W111	GMAKAN	F
24W IV B-4	R/R CABLE ASSY W112	GMAKAS	F
24W IV B-4	R/R CABLE ASSY W149	GMAKEE	F
24W IV B-4	R/R CABLE ASSY W150	GMAKEJ	F
24W IV B-4	R/R CABLE ASSY W151	GMAKEN	F
24W IV B-4	R/R CABLE ASSY W152	GMAKES	F
24W IV B-4	R/R CABLE ASSY W153	GMAKEU	F
24W IV B-4	R/R CABLE ASSY W154	GMAKEZ	F
24W IV B-4	R/R CABLE ASSY W109	GMALEEDJ	F
24W IV B-4	R/R CABLE ASSY W110	GMALJEDJ	F
24W IV B-4	R/R CABLE ASSY W155	GMF2BE	F
24W IV B-4	R/R CABLE ASSY W3	GMMADAB	F
24W IV B-4	R/R CABLE ASSY W4	GMMADAC	F
24W IV B-4	R/R CABLE ASSY W5	GMMADAD	F
24W IV B-4	R/R CABLE ASSY W6	GMMADAE	F
24W IV B-4	R/R CABLE ASSY W9	GMMADAH	F
24W IV B-4	R/R CABLE ASSY W22	GMMADAQ	F
24W IV B-4	R/R CABLE ASSY W23	GMMADAR	F
24W IV B-4	R/R CABLE ASSY W25	GMMADAS	F
24W IV B-4	R/R CABLE ASSY W41	GMMADAT	F
24W IV B-4	R/R CABLE ASSY W27	GMMADAU	F
24W IV B-4	R/R CABLE ASSY W29	GMMADAX	F
24W IV B-4	R/R CABLE ASSY W30	GMMADAY	F
24W IV B-4	R/R CABLE ASSY W33	GMMADBC	F
24W IV B-4	R/R CABLE ASSY W49	GMMADBD	F
24W IV B-4	R/R CABLE ASSY W55	GMMADBE	F
24W IV B-4	R/R CABLE ASSY W56	GMMADBF	F
24W IV B-4	R/R CABLE ASSY W57	GMMADBG	F
24W IV B-4	R/R CABLE ASSY W26	GMMADEN	F
24W IV B-4	R/R CABLE ASSY W58	GMMADDE	F
24W IV B-4	R/R CABLE ASSY W59	GMMADDJ	F
24W IV B-4	R/R CABLE ASSY W45	GMMADDN	F
24W IV B-4	R/R CABLE ASSYS TURRET	GMMBFAA	F
24W IV B-4	R/R CABLE ASSY W101	GMMBFAA	F
24W IV B-4	R/R CABLE ASSY W107	GMMBFAB	F
24W IV B-4	R/R CABLE ASSY W113	GMMBFAG	F
24W IV B-4	R/R CABLE ASSY W115	GMMBFAH	F
24W IV B-4	R/R CABLE ASSY W116	GMMBFAJ	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R GEAR PLUG	CHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R LEVER ASSEMBLY	CHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R MOUNTING BRACKET	CHMBEM	F
24W IX B-1	REPAIR AZIMUTH LOCK BY R/R MOUNTING BLOCK	CHMBEM	F
24W IX B-1	REPAIR PCU RACK BY R/R SHOCK MOUNT	CHMRJ	F
24W IX B-1	REPAIR GAS SEAL BARRIER BY R/R LEVER COVER	CHMTJ	F
24W IX B-1	REPAIR GAS SEAL BARRIER BY R/R PROTECTIVE COVERS	CHMTJ	F
24W IX B-1	REPAIR GAS SEAL BARRIER BY R/R TURRET INTERLOCK SWITCH	CHMTJ	F
24W IX B-1	REPAIR GAS BARRIER ACCESS PANEL BY R/R GASKET STRIPS	CHMTJCK	F
24W IX B-2	REPAIR SQUAD LEADER'S HATCH BY R/R TORSION BARS	CHMAPAD	F
24W IX B-2	REPAIR SQUAD LEADER'S HATCH BY R/R STRIKER PLATE	CHMAPAD	F
24W IX B-2	REPAIR SQUAD LEADER'S HATCH BY R/R BUMP STOP	CHMAPAD	F
24W IX B-2	REPAIR SQUAD LEADER'S HATCH BY R/R COMPRESSION SPRING	CHMAPADAA	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R TORSION BAR	CHMAPAE	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R STRIKER PLATE	CHMAPAE	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R SPRING	CHMAPAE	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R VISION BLOCK	CHMAPAEAA	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R SPRING PIN	CHMAPAFAA	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R PLUNGER	CHMAPAFAA	F
24W IX B-2	REPAIR GUNNER'S HATCH BY R/R HAIR PIN CLIP	CHMAPAFAA	F
24W IX B-2	REPAIR LOADING HATCH BY R/R SAFETY LOCK	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R ADAPTER	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R COMPRESSION SPRING	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R TORSION BARS	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R CONTROL CABLE	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R PULL ROD ASSY	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R TORSION BAR ANCHOR	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R "T" HANDLE	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R SPRING PINS (3)	CHMAPAF	F
24W IX B-2	REPAIR LOADING HATCH BY R/R TORSION BAR HINGE	CHMAPAF	F
24W IX B-3	REPAIR L/R MAINTENANCE HOOD BY R/R STRAIGHT HEADED PIN	CHMAPAAC/H	Q
24W IX B-3	REPAIR L/R MAINTENANCE HOODS BY R/R THRUST WASHER	CHMAPAAC/H	Q
24W IX B-3	REPAIR RIGHT MAINTENANCE HOOD BY R/R BEARINGS	CHMAPAACH	Q
24W IX B-3	REPAIR L/R MAINTENANCE HOOD BY R/R BEARING	CHMAPAACH/K	Q
24W IX B-3	REPAIR L/R MAINTENANCE HOOD BY R/R QUICK RELEASE PIN	CHMAPAC/H	Q
24W V B-1	R/R WAVEGUIDE DESICCANTS #3-7	CHF3	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R MICROSWITCH S-1	CHF3	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R MICROSWITCH S-2	CHF3	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R ISOLATOR HY1	CHF3	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R ISOLATOR HY3	CHF3	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R ISOLATOR HY4	CMF3	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R CIRCULATOR HY2	CMF3	F
24W V B-1	R/R CABLE ASSY W1005	CMFAFNABJ	F
24W V B-1	R/R CABLE ASSY W1006	CMFAFNABK	F
24W V B-1	R/R CABLE ASSY W1007	CMFAFNABL	F
24W V B-1	R/R CABLE ASSY W1008	CMFAFNABM	F
24W V B-1	R/R CABLE ASSY W1009	CMFAFNABN	F
24W V B-1	R/R WAVEGUIDE ASSY 1W14	CMFJE	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R WAVEGUIDE ASSY 1W15	CMFJG	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R WAVEGUIDE ASSY 1W16	CMFJJ	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R WAVEGUIDE ASSY 1W17	CMFJL	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R WAVEGUIDE ASSY 1W18	CMFJN	F
24W V B-1	REPAIR F/C INTERFACE EQUIPMENT BY R/R WAVEGUIDE ASSY 1W19	CMFJP	F
24W V B-1	R/R WAVEGUIDE ASSY 1W20	CMFJR	F
24W V B-1	R/R WAVEGUIDE ASSY 1W21	CMFJT	F
24W V B-1	R/R WAVEGUIDE ASSY 1W22	CMFJV	F
24W V B-1	R/R WAVEGUIDE ASSY 1W23	CMFJX	F
24W V B-1	R/R WAVEGUIDE ASSY 1W24	CMFJZ	F
24W V B-1	R/R CABLE ASSY W1002	CMMBFJJ	F
24W V B-1	R/R CABLE ASSY W1010	CMMBFKR	F
24W V B-1	R/R CABLE ASSY W1011	CMMBFKV	F
24W V B-1	R/R CABLE ASSY W1012	CMMBFKZ	F
24W V B-1	R/R CABLE ASSY W1013	CMMBFLE	F
24W V B-2	R/R IDENTIFICATION - FRIEND OR FOE (IFF)	CMFAE	Q
24W V B-2	R/R ANTENNA ELECTRONICS	CMFAFAACA	Q
24W V B-2	R/R RECEIVER/STALO	CMFAFGA	F
24W V B-2	R/R POWER SUPPLY ASSY	CMFAFGAAB	Q
24W V B-2	R/R LOW NOISE AMPLIFIER ASSY	CMFAFGAAC	F
24W V B-2	R/R MULTIPLIER ASSY	CMFAFGAAD	F
24W V B-2	R/R REFERENCE OSCILLATOR MODULE	CMFAFGAAE	F
24W V B-2	R/R TRANSMIT MICROWAVE MODULE	CMFAFGAAF	F
24W V B-2	R/R SYNTHESIZER MODULE	CMFAFGAAG	F
24W V B-2	R/R RECEIVER MODULE	CMFAFGAAH	F
24W V B-2	R/R CONTROL ANALOG CCA #1	CMFAFGAAJ	F
24W V B-2	R/R CONTROL INTERFACE CCA	CMFAFGAAK	F
24W V B-2	R/R CONTROL CPU CCA	CMFAFGAAL	F
24W V B-2	R/R SAMPLE DATA CCA	CMFAFGAAM	F
24W V B-2	R/R RADAR TRANSMITTER	CMFAFJA F	F
24W V B-2	R/R RADAR PROCESSOR	CMFAFLA F	F
24W V B-3	R/R TRACK ANTENNA	CMFAFAAA	Q

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W V B-3	REPAIR TRACK ANTENNA STOW ACTUATOR BY R/R TRACK ANTENNA STOP	CMFAFAAAA	Q
24W V B-3	REPAIR TRACK ANTENNA STOW ACTUATOR BY R/R THE LINKAGE PRELOAD CAM	CMFAFAAAA	Q
24W V B-3	R/R TRACK ANTENNA LOWER LINK	CMFAFAAAAAK	Q
24W V B-3	R/R TRACK ANTENNA UPPER LINK	CMFAFAAAAAL	Q
24W V B-3	R/R TRACK ANTENNA HYD FILTER ELEMENT	CMFAFAAAABY	F
24W V B-3	R/R TRACK ANTENNA STOW ACTUATOR	CMFAFAAAACF	Q
24W V B-3	R/R TRACK ANTENNA RADOME	CMFAFAAABAB	F
24W V B-3	R/R SEARCH ANTENNA	CMFAFAAE	Q
24W V B-3	R/R SEARCH ANTENNA HYD. FILTER ELEMENT	CMFAFAAEAAR	F
24W V B-3	R/R SEARCH ANTENNA RADIATOR ASSY	CMFAFAAEB	F
24W V B-3	R/R SEARCH ANTENNA RADOME	CMFAFAAEBAE	F
24W VI B-1	R/R RECEIVER PLUG ASSY	CMF2AGM	F
24W VI B-1	REPAIR RECEIVER BY R/R RECEIVER WINDOW PLUG	CMF2AGM	F
24W VI B-1	R/R LASER TRANSMITTER	CMF2C	Q
24W VI B-1	R/R LASER RECEIVER	CMF2D	Q
24W VI B-1	R/R LASER ELECTRONICS UNIT	CMF2E	Q
24W VI B-1	R/R CABLE W2001	CMF2JE	F
24W VI B-1	R/R CABLW W2002	CMF2JJ	F
24W VI B-1	R/R CABLE W2003	CMF2JN	F
24W VI B-2	R/R GUNSIGHT TELESCOPE	CMF2A	F
24W VI B-2	R/R GUNSIGHT CONTROL PANEL	CMF2AJE	Q
24W VI B-2	R/R GUNSIGHT SSU	CMF2B	Q
24W VI B-2	REPAIR GUNSIGHT SSU BY R/R DESICCANT	CMF2B	F
24W VI B-2	PRESSURIZE/PURGE GUNSIGHT TELESCOPE	CMF2B	F
24W VI B-2	R/R GUNSIGHT SSU WIPER BLADE ASSY	CMF2BABCEG	F
24W VI B-3	R/R PERISCOPE TELESCOPE	CMF1A	Q
24W VI B-3	REPAIR PERISCOPE TELESCOPE BY R/R HUMIDITY INDICATOR PLUG	CMF1A	Q
24W VI B-3	R/R PERISCOPE CONTROL PANEL	CMF1AJE	Q
24W VI B-3	R/R PERISCOPE SSU	CMF1B	Q
24W VI B-3	PRESSURIZE/PURGE PERISCOPE TELESCOPE SSU	CMF1B	F
24W VI B-3	REPAIR PERISCOPE SSU BY R/R DESICCANT	CMF1B	F
24W VI B-3	R/R PERISCOPE SSU WIPER BLADE ASSY	CMF1B	F
24W VI B-3	REPAIR WIPER ARM ASSY BY R/R WIPER TIE ARM ASSY	CMF1BAAAC	F
24W VI B-3	R/R WIPER ARM ASSY	CMF1BAAAC	F
24W VI B-3	REPAIR WIPER ARM ASSY BY R/R WINDOW WIPER ASSY	CMF1BAAAC	F
24W VI B-3	REPAIR PERISCOPE TELESCOPE BY R/R HUMIDITY INDICATOR PLUG	CMF2A	Q
24W VI C-1	PERFORM FIELD/REPLACEMENT BORESIGHT	CS	Q
24W VI C-1	INSTALL/REMOVE BORESIGHT PSE	SGRAV	Q
24W VII A-2	REPAIR MAKE-UP AIR PLENUM BY R/R SEAL	CMMAVABBL	F
24W VII B-1	R/R HEAT EXCHANGE FAN	CMMAQAF	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W VII B-1	R/R RECIRCULATION FAN	GMMAVABCR	Q
24W VII B-1	R/R MAKE-UP AIR VALVE	GMMAVAD	Q
24W VII B-1	REPAIR MAKE-UP AIR VALVE BY R/R SLEEVE	GMMAVAD	Q
24W VII B-1	R/R MAKE-UP AIR VALVE FLEX HOSE	GMMAVAE	Q
24W VII B-1	R/R FACING PLATE ASSY	GMMAVAF	Q
24W VII B-1	REPAIR RECIRCULATION FAN SHROUD BY R/R PUSH-PULL CABLE	GMMAVAG	Q
24W VII B-1	R/R RECIRCULATION FAN SHROUD	GMMAVAG	Q
24W VII B-1	R/R RECIRCULATION FAN VENT FILTER	GMMAVAJ	Q
24W VII B-1	REPAIR RECIRCULATION FAN HOUSING BY R/R BULB SEAL	GMMAVAK	F
24W VII B-1	REPAIR RECIRCULATION FAN HOUSING BY R/R RECEPTACLE	GMMAVAK	F
24W VII B-1	REPAIR RECIRCULATION FAN HOUSING BY R/R FAN	GMMAVAK	Q
24W VII B-1	REPAIR RECIRCULATION FAN HOUSING BY R/R SHOULDER SCREW	GMMAVAK	Q
24W VII B-1	R/R EXHAUST DOOR	GMMAVAL	Q
24W VII B-2	R/R ENVIRONMENTAL CONTROL UNIT (ECU)	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R LONG RAIL ISOLATOR	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R SHORT RAIL ISOLATOR	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R OVERRIDE SWITCH	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R LONG MOUNTING RAIL	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R SHORT MOUNTING RAIL	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R BEVEL MOUNTING RAIL	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R BEVEL RAIL ISOLATOR	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R TIME METER	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R FRAME CONNECTING PLATE	GMMAVAB	Q
24W VII B-2	REPAIR ECU BY R/R CONDENSER SEALS	GMMAVAB	Q
24W VII B-3	R/R ROTARY AIR JOINT	GMMAW	F
24W VII B-3	R/R ROTARY AIR JOINT TUBE HOSE ADAPTER ASSY	GMMAW	F
24W VII B-3	R/R FLOOR PLENUM ELBOW DUCT	GMMAW	F
24W VII B-3	R/R L/R FIREWALL FLEX HOSES	GMMAW	F
24W VII B-3	R/R ARU INLET DUCT	GMMAW	F
24W VII B-3	R/R ARU FLEX HOSE	GMMAW	F
24W VII B-3	R/R INBOARD DUCT	GMMAW	F
24W VII B-3	R/R CONTROL VALVE DUCT	GMMAW	F
24W VII B-3	R/R ROTARY AIR JOINT LEFT COVER ASSY	GMMAWAE	F
24W VII B-3	REPAIR LEFT ROTARY AIR JOINT COVER ASSY BY R/R RUB STRIP	GMMAWAE	F
24W VII B-3	R/R ROTARY AIR JOINT RIGHT COVER ASSY	GMMAWAJ	F
24W VII B-3	R/R ROTARY AIR JOINT LEFT BASE ASSY	GMMAWAN	F
24W VII B-3	REPAIR RIGHT ROTARY AIR JOINT BASE ASSY BY R/R SEAL	GMMAWAN	F
24W VII B-3	R/R ROTARY AIR JOINT RIGHT BASE ASSY	GMMAWAR	F
24W VII B-3	REPAIR ROTARY AIR JOINT RIGHT BASE BY R/R LATCH	GMMAWAR	F
24W VII B-3	R/R TRANSMITTER INLET DUCT	GMMAWAX	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W VII B-3	REPAIR TRANSMITTER INLET DUCT BY R/R SEAL	CMMAWAX	F
24W VII B-3	R/R TRANSMITTER OUTLET DUCT	CMMAWBE	F
24W VII B-3	REPAIR TRANSMITTER OUTLET DUCT BY R/R SEAL	CMMAWBE	F
24W VII B-3	R/R CONDITIONED AIR DUCT	CMMAWBJ	F
24W VII B-3	REPAIR CONDITIONED AIR BRANCH DUCT BY R/R SEAL	CMMAWBJ	F
24W VII B-3	R/R ANTENNA ELECTRONICS OUTLET DUCT	CMMAWBN	F
24W VII B-3	REPAIR ANTENNA ELECTRONICS OUTLET DUCT BY R/R SEAL	CMMAWBN	F
24W VII B-3	R/R DSC DIST PLENUM	CMMAWBR	F
24W VII B-3	REPAIR DSC COOLING DUCT BY R/R SEAL	CMMAWBR	F
24W VII B-3	R/R HEATER/VENT ASSY	CMMAWBV	F
24W VII B-3	REPAIR HEATER VENT ASSY BY R/R DOOR	CMMAWBV	F
24W VII B-3	REPAIR HEATER VENT ASSY BY R/R SEAL	CMMAWBV	F
24W VII B-3	R/R AFTWALL DUCT	CMMAWBX	F
24W VII B-3	REPAIR AFT WALL DUCT BY R/R "T" DEGREE SWITCH	CMMAWBX	F
24W VII B-3	R/R FORWARD OUTLET DUCT	CMMAWCE	F
24W VII B-3	REPAIR FORWARD OUTLET DUCT ASSY BY R/R SEAL	CMMAWCE	F
24W VII B-3	R/R FLOOR BEAM DUCT	CMMAWCJ	F
24W VII B-3	REPAIR FLOOR BEAM DUCT BY R/R AIR OUTLET	CMMAWCJ	F
24W VII B-3	REPAIR FLOOR BEAM DUCT BY R/R SEAL	CMMAWCJ	F
24W VII B-3	REPAIR FLOOR BEAM DUCT BY R/R AIR OUTLET SEAL	CMMAWCJ	F
24W VII B-3	R/R RADAR PROCESSOR DUCT	CMMAWCN	F
24W VII B-3	REPAIR RADAR PROCESSOR DUCT BY R/R SEAL	CMMAWCN	F
24W VII B-3	R/R CONTROL VALVE ASSY	CMMAWCR	F
24W VII B-3	REPAIR CONTROL VALVE ASSY BY R/R HANDLE	CMMAWCR	F
24W VII B-3	REPAIR AIR OUTLET ASSY BY (TBD)	CMMAWCV	NC
24W VII B-3	R/R AIR OUTLET ASSY	CMMAWCV	F
24W VII B-3	REPAIR AIR OUTLET ASSY BY R/R GASKET	CMMAWCV	F
24W VII B-3	REPAIR L/H FLOOR PLENUM (TBD)	CMMAWEN	NC
24W VII B-3	REPAIR R/H FLOOR PLENUM (TBD)	CMMAWER	NC
24W VIII B-1	R/R SLIP RING BRIDLES ASSY	CMMACE	F
24W VIII B-1	REPAIR SLIP RING BRIDLE BY (TBD)	CMMACE	NC
24W VIII B-1	REPAIR SLIP RING BRIDLE BY (TBD)	CMMACE	NC
24W VIII B-1	REPAIR SLIP RING BRIDLE BY (TBD)	CMMACE	NC
24W VIII B-1	REPAIR SLIP RING BRIDLE BY (TBD)	CMMACE	NC
24W VIII B-1	REPAIR SLIP RING BRIDLE BY (TBD)	CMMACE	NC
24W VIII B-1	R/R SLIP RING	CMMACJE	F
24W VIII B-1	REPAIR HULL HYDRAULICS BY R/R TUBE ASSY #12709609	CMMAM G	0
24W VIII B-1	REPAIR HULL HYDRAULICS BY R/R TUBE ASSY #12709610	CMMAM G	0
24W VIII B-1	REPAIR HULL HYDRAULICS BY R/R TUBE ASSY #12709608	CMMAM G	0
24W VIII B-1	REPAIR HULL HYDRAULICS BY R/R TUBE ASSY #12709607	CMMAM G	0

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W VIII B-1	R/R HULL MANIFOLD	CMMAMAP	Q
24W VIII B-1	REPAIR HULL MANIFOLD BY R/R SYSTEM FILTER MANIFOLD	CMMAMAP	Q
24W VIII B-1	REPAIR HULL MANIFOLD BY R/R CASE DRAIN FILTER MANIFOLD	CMMAMAP	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R HOSE ASSY 12603316	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R HOSE ASSY 12601175	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R HOSE ASSY 12717673	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R HOSE ASSY 12716721	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R TUBE ASSY 12717669	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R TUBE ASSY 12617191	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R TUBE ASSY 12617189	CMMAR	Q
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R INNER SHAFT	CMMAR	F
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY R/R SHAFT	CMMAR	F
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY FLEX COUPLING	CMMAR	F
24W VIII B-1	REPAIR PTO GEARBOX ASSY BY TUBE CROSS	CMMAR	F
24W VIII B-1	R/R AUXILIARY HYDRAULIC PUMP	CMMARE	Q
24W VIII B-1	R/R GEARBOX ADAPTER	CMMART	Q
24W VIII B-1	R/R PTO GEARBOX	CMMARW	Q
24W VIII B-1	R/R PRIMARY HYDRAULIC PUMP	CMMER	Q
24W VIII B-2	R/R HEAT EXCHANGER	CMMBAAM	F
24W VIII B-2	REPAIR HEAT EXCHANGER BY R/R TEMPERATURE & PRESSURE REG. VALVE	CMMBAAM	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603708	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603181	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603210	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603199	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603709	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603710	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603707	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603701	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603711	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TUBE ASSY #12603156	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R SIGHT GLASS	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R SWIVEL TEE	CMMBABY	Q
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R TRUNNION MOUNTING STRAP	CMMBABY	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R BLEED VALVE	CMMBABYAN	F
24W VIII B-2	REPAIR MAIN RESERVOIR BY R/R CYLINDER FILTER ASSY	CMMBABYAN	F
24W VIII B-2	R/R REPLENISHMENT RESERVOIR	CMMBABYAP	Q
24W VIII B-2	REPAIR FILTER MANIFOLD BY R/R FILTER ELEMENT	CMMBABYAR	Q
24W VIII B-2	R/R FILTER MANIFOLD	CMMBABYAR	Q
24W VIII B-2	REPAIR FILTER MANIFOLD BY R/R DIFF. PRES. IND. SWITCH	CMMBABYAR	Q
24W VIII B-2	REPAIR FILTER MANIFOLD BY R/R SOLENOID VALVE ASSY	CMMBABYAR	Q

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN	Task Status
24W VIII B-2	R/R MANUAL REPLENISHMENT HAND PUMP	CMMBABYAT	Q
24W VIII B-2	REPAIR MANUAL REPLENISHMENT HAND PUMP BY R/R HANDLE	CMMBABYAT	Q
24W VIII B-2	REPAIR SDA BY R/R PRESURE SWITCH	CMMBACD	F
24W VIII B-2	REPAIR SDA ASSY BY R/R NITROGEN CYLINDER	CMMBACD	Q
24W VIII B-2	R/R NITROGEN MANIFOLD	CMMBACD	Q
24W VIII B-2	REPAIR SDA BY R/R N_2 GAGE	GIMBACD	Q
24W VIII B-2	REPAIR SDA BY R/R TUBE ASSEMBLIES (4)	CMMBACD	Q
24W VIII B-2	R/R SYSTEM ACCUMULATOR	GIMBACDAM	Q
24W VIII B-2	R/R SDA EXCITER AMPLIFIER	CMMBACDBR	
24W VIII B-2	REPAIR SDA BY R/R TRANSDUCER	CMMBACDCE	Q
24W VIII B-2	REPAIR ELEVATION MANIFOLD BY R/R ELEVATION MANIFOLD ACCUMULATOR	CMMBAHQ	Q
24W VIII B-3	REPAIR PTO GEARBOX BY R/R CONNECTOR	CMMARW	
24W VIII B-3	R/R RADAR ANTENNA MANIFOLD	CMMBAHP	F
24W VIII B-3	R/R ELEVATION MANIFOLD	CMMBAHQ	F
24W VIII B-3	R/R MANUAL ELEVATION DRIVE HAND PUMP	CMMBAJV	F
24W VIII B-3	REPAIR MANUAL ELEVATION DRIVE HAND PUMP BY R/R HANDWHEEL	CMMBAJV	F
24W VIII B-3	R/R ELEVATION ACTUATOR	CMMBDJ	Q
24W VIII B-3	R/R MANUAL DRIVESHAFT ASSEMBLY	CMMBE	Q
24W VIII B-3	R/R RIGHT ANGLE GEARBOX	CMMBE	F
24W VIII B-3	REPAIR L/R AZIMUTH DRIVE BY R/R BASE	CMMBE	Q
24W VIII B-3	REPAIR L/R AZIMUTH DRIVE BY R/R AZIMUTH MOTOR ENCLOSURE	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R LEFT MANIFOLD FLANGE	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R RIGHT MANIFOLD FLANGE	CMMBE	F
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R LEFT HOSE COVER	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R RIGHT HOSE COVER	CMMBE	F
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12601156-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12601184-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12603298-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12603308-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12601181-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12601170-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12603303-1	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R HOSE #12603303-2	CMMBE	Q
24W VIII B-3	REPAIR AZIMUTH DRIVE BY R/R TUBE #12619999-1	CMMBE	Q
24W VIII B-3	REPAIR DRIVE SHAFT ASSY BY R/R ADAPTER	CMMBEA	F
24W VIII B-3	R/R RIGHT AZIMUTH DRIVE GEARBOX	CMMBEE	F
24W VIII B-3	R/R LEFT AZIMUTH DRIVE MOTOR	CMMBEF	Q
24W VIII B-3	R/R RIGHT AZIMUTH DRIVE MOTOR	CMMBEF	F
24W VIII B-3	R/R LEFT AZIMUTH DRIVE GEARBOX	CMMBEJ	Q
24W VIII B-3	R/R MANUAL AZIMUTH DRIVE GEARBOX	CMMBEJE	F

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Task No	Lesson Number	Task Title	LSACN	Task Status
21162	24W VIII B-3	R/R AZIMUTH DRIVE GEARBOX ACTUATOR	GMMBEJG	F
21173	24W VIII B-3	R/R MANUAL DRIVE ASSY	GMMBEQ	F
21174	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R COMPRESSION SPRING	GMMBEQ	F
21175	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R ROLLER BEARING	GMMBEQ	F
21176	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R YOKE ASSY	GMMBEQ	F
21177	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R HANDLE	GMMBEQ	F
21178	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R BASE PLATE	GMMBEQ	F
21179	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R ROTATING SHAFT	GMMBEQ	F
21180	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R TUBE SLIDING	GMMBEQ	F
21181	24W VIII B-3	REPAIR MANUAL AZIMUTH DRIVE BY R/R SLIDING LATCH	GMMBEQ	F
20190	24W VIII B-3	R/R RIGHT AZIMUTH MOTOR MANIFOLD ASSY	GMMBER	F
20871	24W VIII B-3	REPAIR RIGHT AZIMUTH MOTOR MANIFOLD BY R/R PRESSURE SWITCH	GMMBER	F
20189	24W VIII B-3	R/R LEFT AZIMUTH MOTOR MANIFOLD ASSY	GMMBER	Q
20822	24W VIII B-3	REPAIR LEFT AZIMUTH MOTOR MANIFOLD BY R/R PRESSURE SWITCH	GMMBER	F
20962	24W VIII B-3	REPAIR L/R MANIFOLD ASSY BY R/R SUPPORT BRACKET	GMMBER	F
20330	24W VIII B-4	CHARGE SYSTEM ACCUMULATOR	GMMBACD	Q
21245	24W VIII B-4	CHARGE SDA	GMMBACD	Q
20987	24W VIII B-5	REPAIR HYDRAULIC TUBING	G15	NC
21229	24W VIII B-5	R/R TASK & REQ. OF TUBE & HOSE ASSY	G15	NC
20121	24W X B-1	R/R AMBIENT TEMPERATURE SENSOR	GMF	F
20081	24W X B-1	R/R DATA SYSTEM CONTROLLER (DSC)	GMFAC	F
21044	24W X B-1	REALIGN DSC NVM AFTER REPLACEMENT OF DSC	GMFAC	F
20109	24W X B-1	R/R SQUAD LEADER'S CONTROL PANEL	GMFAHAB	F
20458	24W X B-1	R/R YOKE ASSY	GMFAHAD	F
20110	24W X B-1	R/R DISPLAY	GMFAHC	F
20111	24W X B-1	R/R GUNNER'S CONTROL PANEL	GMFAJAB	F
20112	24W X B-1	R/R GUNNER'S SUPPORT ARM	GMFALAA	F
20168	24W X B-1	R/R S/L SUPPORT ARM DETENT ASSY	GMFALAAJ	F
20113	24W X B-1	R/R GUNNER'S LEFT CONTROL GRIP	GMFALAC	F
20116	24W X B-1	R/R SQUAD LEADER'S LEFT CONTROL GRIP	GMFALAC	F
20114	24W X B-1	R/R GUNNER'S RIGHT CONTROL GRIP	GMFALAD	F
20117	24W X B-1	R/R SQUAD LEADER'S RIGHT CONTROL GRIP	GMFALAD	F
20115	24W X B-1	R/R SQUAD LEADER'S SUPPORT ARM	GMFAMAA	F
20118	24W X B-1	R/R DISPLAY PROCESSOR UNIT (DPU)	GMFAN	F
20119	24W X B-1	R/R WIND SENSOR	GMFCF	F
20120	24W X B-1	R/R PRESSURE SENSOR	GMFCG	F
20082	24W X B-1	R/R ATTITUDE REFERENCE UNIT (ARU)	GMFD F	F
20132	24W X B-1	R/R AZIMUTH BEARING RESOLVER	GMMACJN	F
20105	24W X B-2	R/R FIRE CONTROL COMPUTER (FCC)	GMFAG	F
20314	24W XI A-2	REPAIR RELOADER ASSY BY REPLACING RELOADER LATCH	SBEAV	NC

Appendix C (Cont.)

STATUS OF TRAINING FOR 24W MOS

Lesson Number	Task Title	LSACN		Task Status
24W XI A-2	REPAIR RELOADER ASSY BY REPLACING RELOADER PAWL ROUND STOP	SBEAV		NC
24W XI A-2	REPAIR RELOADER ASSY BY REPLACING RELOADER RELEASE CABLE	SBEAV		NC
24W XI A-2	REPAIR RELOADER ASSY BY REPLACING RELOADER RELEASE HANDLR	SBEAV		NC
24W XI A-2	REPAIR RELOADER ASSY BY REPLACING RELOADER SWITCH ROD ASSY	SBEAV		NC
24W XI A-2	REPAIR RELOADER ASSY BY REPAIRING BENT RELOADER FRAME	SBEAV		NC
24W XI A-2	REPAIR SSU PURGE KIT	SDE		NC
24W XI A-2	SERVICE SSU PURGE KIT	SDE		NC
24W XI A-2	SERVICE PSR LIFTING AIDS	SEEAJ /		NC
24W XI A-2	REPAIR AUTOLOADER LIFTING BRACKET BY (TBD)	SEEAJAN		NC
24W XI A-2	REPAIR ARTICULATING ADAPTER BY R/R SWIVEL SCREW CLAMP	SEEAJBR		NC
24W XI A-2	REPAIR ARTICULATING ADAPTER BY R/R BEARING	SEEAJBR		NC
24W XI A-2	REPAIR ARTICULATING ADAPTER BY R/R WORM GEAR	SEEAJBR		NC
24W XI A-2	REPAIR ARTICULATING ADAPTER BY R/R CABLE ASSY	SEEAJBR		NC
24W XI A-2	REPAIR ARTICULATING ADAPTER BY R/R WORM	SEEAJBR		NC
24W XI A-2	REPAIR ARTICULATING ADAPTER BY R/R LOCK PIN	SEEAJBR		NC
24W XI A-2	PERFORM SCHEDULED SERVICE ON BOOMHOIST MTR BTY	SEEAN		F
24W XI A-2	PERFORM SCHEDULED SERVICE ON BOOMHOIST	SEEAN		F
N/A	REPAIR CHARGING VALVE BY R/R CAP	GMMBACDCE	CFE	F
N/A	REPAIR L/R OUTBOARD TRUNNION HUB BY R/R BEARING	GMALNN/RN	Redesign	F
N/A	PERFORM SCHEDULED SERVICE ON THE PPU	GMMEC	Redesign	F
N/A	CLEAN OPTICS SUBSYSTEM LRUs	GMFIA, B/2A, B F	See Task #s 20073-75	
N/A	PERFORM SCHEDULED SERVICE ON THE TPT	TA	Redesign	NC
N/A	R/R CHARGING VALVE	GMMBACDCE	CFE	F
N/A	REPAIR EYEPIECES BY R/R SUPPORT HOUSING STUD	GAFIBAAAG		F
N/A	R/R BATTERIES	GHB	63N	F
N/A	FILL STORAGE BATTERY	GHB	63N	F
N/A	R/R FEED SYSTEM SENSORS	GMA	Ref to Tasks #20770-5, 20764-9, 21238-40	
N/A	REPAIR SYNCHRO ASSY BY R/R L/H PLUNGER	GMAS		NC
N/A	REPAIR SYNCHRO ASSY BY R/R R/H PLUNGER	GMAS		NC
N/A	REPAIR SYNCHRO ASSY BY R/R L/H PLUNGER SPRING	GMAS		NC
N/A	REPAIR SYNCHRO ASSY BY R/R R/H PLUNGER SPRING	GMAS		NC
N/A	REPAIR SYNCHRO ASSY BY R/R R/H SYNCHRO BAR	GMAS		NC
N/A	R/R RIGHT GUNSAFE SENSOR	GMAAKCV	Redesign	F
N/A	R/R LEFT GUNSAFE SENSOR	GMAAKCW	Redesign	F
N/A	R/R LEFT EJECTION CLOSURE	GMAAKAR	Redesign	NC
N/A	REPAIR RIGHT EJECTION CLOSURE BY R/R CLOSURE GASKET	GMAAKAR	Redesign	NC
N/A	R/R RIGHT EJECTION CLOSURE	GMAAKAT	Redesign	NC
N/A	REPAIR LEFT EJECTION CLOSURE BY R/R CLOSURE GASKET	GMAARAT	Redesign	NC
N/A	REPAIR HYD ROLLING LOOP BY R/R HOSE ASSY	GMABL	Redesign	NC
N/A	REPAIR HYD ROLLING LOOP BY R/R HOSE ASSY	GMABL	Redesign	NC